Configuring RAID in a Dell workstation

How to setup a custom RAID configuration - Precision 7960 Tower

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1 Introduction

This chapter provides introduction to this document along with the scope and Glossary of terms.

1.1 Overview

This document helps with configuring RAID volumes on SATA, SAS, and NVMe drives using Intel Virtual RAID on CPU (Intel VROC) and Broadcom MegaRAID SAS 9540-8i and 9660-16i RAID controllers. Intel VROC supports only SATA and NVMe drives. MegaRAID SAS 9540-8i/9660-16i support SAS, SATA, and NVMe drives.

This document only gives a high-level overview to manage RAID configurations. To get detailed explanation of RAID related terms, and technologies refer to the documentation and specifications of the corresponding controller/technology/protocol.

1.2 Scope

This document provides examples for RAID configurations using the Precision 7960 Tower platform. In this platform, Intel VROC, MegaRAID SAS 9540-8i and MegaRAID SAS 9660-16i are the supported controllers. So only these controllers are used to explain RAID configurations.

In some of the screenshots, a firmware version may be listed. The versions are to be treated as examples only. Actual firmware version on your installation may be slightly different than what is presented in this document.

NVMe related sections are new to the current platforms and did not present in previous generations. As a new technology NVMe related sections are subject to change as the technology evolves.

1.3 Glossary of Terms

Table 1 Definition of terms found throughout this document

Acronym/Terminology	Remarks
SAS	Serial attached SCSI. More info: http://www.t10.org/
SATA	Serial ATA. ATA stands for AT attachment. More info: http://www.sata-io.org/
PCIe	PCI Express. More info: https://pcisig.com/specifications/pciexpress/
NVMe	NVM Express. NVM stands for Non-Volatile Memory. http://nvmexpress.org/
Intel VMD	Intel Volume Management Device (Intel VMD)
Intel VROC	Intel Virtual RAID on CPU (Intel VROC)
PCIe HSBP	PCIe High speed Backplanes – required to connect NVMe drives
HDD	Hard Disk Drive

SSD	Solid State Drive
JBOD	Just a Bunch of Disks. Mode that uses raw drives without any RAID configuration.
RAID	Redundant Array of Independent Disks
RAID Array	Set of drives grouped together to form a Drive Group which is also known as Array.
RAID Volume	You may create more than one RAID volume from the same Drive Group. Volume is same as array if the Volume is made of whole drive group/array.
Physical disk	Represent the actual hardware, which could be a SSD, or an HDD.
Virtual Disk/ Logical disk	Each RAID volume is a Virtual Disk, as it represents a Storage disk like a Physical disk, but in a logical manner. Logical Disk may be contained in one physical disk, or it may span more than one disks based on the type of volume.
UEFI Driver, UEFI OROM	UEFI stands for Universal Extensible Firmware Interface. It is the extension of EFI and It is replacing the Legacy OROM and it is superior in terms of scalabilityand features. More info: http://www.uefi.org/

1.4 Related links

- Intel Virtual RAID on CPU (Intel VROC) supported configurations https://www.intel.com/content/www/us/en/support/articles/000030310/memory-and-storage/datacenter-storage-solutions.html
- Intel Virtual RAID on CPU (Intel VROC) Upgrade Key Installation Guide: https://www.intel.com/content/dam/support/us/en/documents/memory-and-storage/ssd-software/Intel_VROC_Upgrade_Key_Install_Guide.pdf
- Intel VROC for Windows User Guide: https://www.intel.com/content/dam/support/us/en/documents/memory-and-storage/ssd-software/Intel_VROC_VMD_Supported_Configs_8_0.pdf
- Intel VROC for Linux Software User Guide: https://www.intel.com/content/dam/support/us/en/documents/memory-and-storage/ssd-software/Linux_VROC_6-0_User_Guide.pdf
- 9540-8i: https://www.broadcom.com/products/storage/raid-controllers/megaraid-9540-8i
- 9660-16i: https://www.broadcom.com/products/storage/raid-controllers/megaraid-9660-16i
- 12Gb/s MegaRAID Tri-Mode Software User Guide: https://docs.broadcom.com/docs/MR-TM-SW-UG

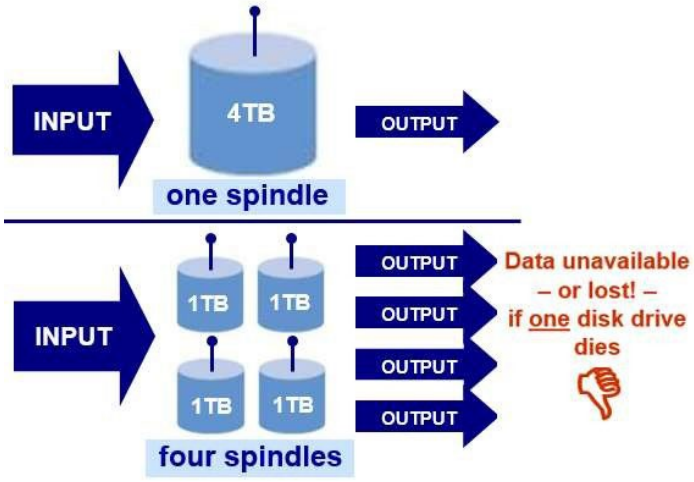
2 RAID Introduction

There are four RAID types supported in Precision 7960 Tower workstation: RAID0, RAID1, RAID5, and RAID10. Other RAID types are available on the MegaRAID SAS controllers, but they have not been validated on these platforms.

Note: Broadcom RAID 9540-8i and 9660-16i controllers support JBOD (Just a Bunch of Disks) mode as well. Though JBOD mode should work fine on Precision 7960 Tower workstation, JBOD mode is not officially supported on these platforms. Single drive RAID0 is recommended for customers who need JBOD mode. Single drive RAID0 provides almost same performance as JBOD,

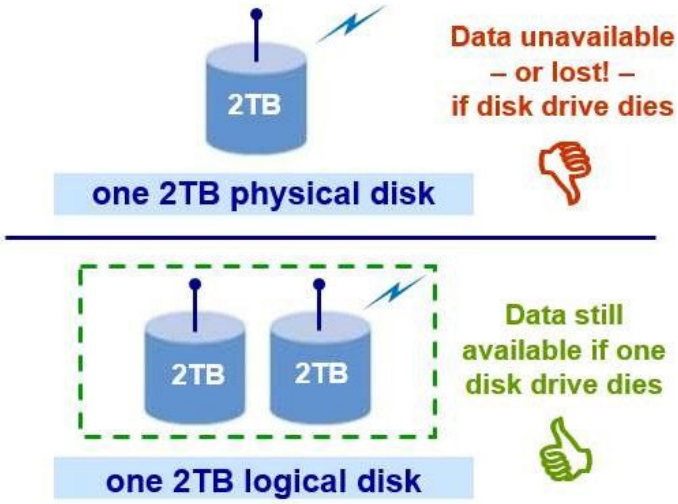
2.1 RAID 0 – Data striping across drives for faster read/write performance

- Two or more drives of same size are required for RAID0.
- Single drive RAID0 volumes are also allowed on the MegaRAID SAS controllers. Single Drive RAID0 is almost equivalent to using raw drives in JBOD mode, in addition it provides cache benefits while using the9660-16i controller which has 4 GB of cache memory.
- On multiple drive RAID0 volumes, Read/write operations are shared concurrently across multiple plattersand heads and so it provides better performance.
- Total volume capacity as seen by the Operating system is equal to the sum of the individual drive capacities. For example, if you use 4 drives of 1 TB size, then you get 4 x 1.0 TB = 4.0 TB
- Advantages – Higher space utilization compared to other volumes. Performance multiples as the numberof drives increase.
- Disadvantage – If any drive in the array fails, all data is lost. No redundancy.



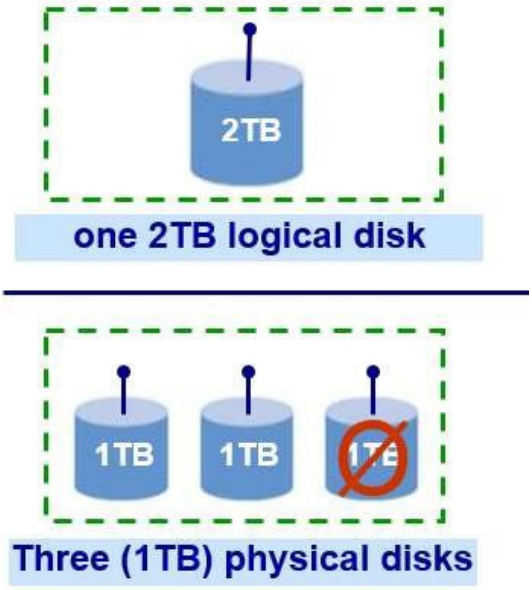
2.2 RAID 1 – Data mirroring (100% redundancy) for data protection

- 100% duplication and instant failover.
- Requires two drives. Same capacity is expected. When two different capacity drives are used, Volume size will be same as that of the smaller drive's capacity. For example, if you use two 2 TB drives, then you get 2 TB of RAID1 volume.
- Advantage – With proper load balancing, read performance can be twice that of a single drive. Write performance is almost same as single drive. Suitable for OS volumes.
- Disadvantage – Cost



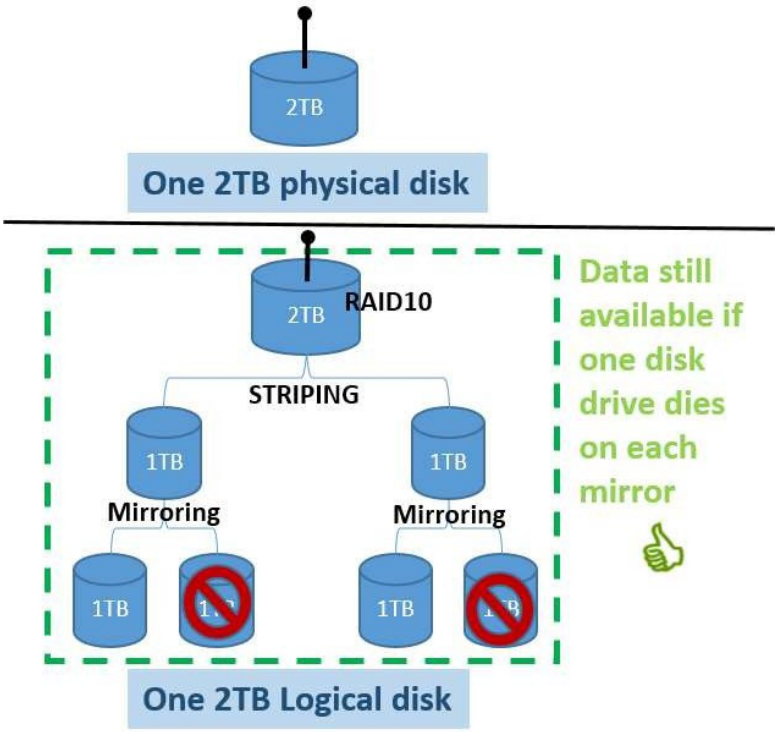
2.3 RAID 5 – Striping (performance) and data protection through parity

- Requires at least three drives
- Data is available even if one of the drives present in the volume fails, however the failed drive must be replaced, and the volume must be rebuilt to for the data to be accessible.
- Total capacity = N-1, e.g. When you use 3 drives of 1.0 TB size, you get a 2.0 TB RAID5 volume
- Disadvantage - rebuilding a large RAID5 volume can take a long time



2.4 RAID 10 – A **stripe of mirrors**

- Combines RAID0 and RAID1. Requires minimum 4 drives. Only even number of drives can be used. Oddnumber of drives are not possible.
- Total capacity = half the sum of individual drives capacity. For example, when you use 4 drives of 1.0 TB, then you get a RAID10 Volume of 2.0 TB.
- Advantage: Higher performance (as blocks are striped), Better redundancy (as blocks are mirrored)
- Disadvantage: Cost.



3 Platforms and Supported Controllers

The workstation used in this guide is the Precision 7960 Tower. The Precision 7960 Tower system supports processors from the Intel Xeon Processor Scalable Family and ship with the W790 chipset. The below table provides details on the different storage controllers and the platform support for each.

Table 2 Controllers supported in each platform

RAID Controller	7960 Tower
Intel VMD with Intel VROC pass-through	Yes (Integrated)
Intel VROC Standard （RAID0 1 10）	Optional SATA SAS, SSD
Intel VROC Premium （RAID0 1 5 10）	Optional SATA SAS, SSD
Broadcom MegaRAID SAS 9540-8i	Optional SATA SAS, SSD
Broadcom MegaRAID SAS 9660-16i	Optional SATA SAS, SSD

*Intel VROC requires optional VROC Key for NVMe RAID support

3.1 Intel VROC

NVMe drives can be directly connected to the CPU PCIe slots using the Dell Ultra-Speed Quad or Dell Ultra- Speed Duo add-in cards or installed into the front FlexBays with an optional PCIe High-Speed Backplane (HSBP). Intel VMD is the storage controller used by drives directly attached to the CPU. Intel VROC is the software stack that manages drives attached to Intel VMD. The integrated Intel VROC pass-through allowsfor NVMe SSDs to be installed onto CPU PCIe connections in JBOD mode only. The Intel VROC Standard upgrade allows drives connected to Intel VMD to be configured into RAID 0, RAID1, or RAID10 arrays.

There are four Intel VMD controllers on the Precision 7960 Tower platform.

Table 3 Intel VMD Controller layout

Controller	7960 Tower
Onboard M.2	Not applicable
VMD Controller 1	REAR NVME 0-1 (2 ports)
VMD Controller 2	REAR NVME 2-3 (2 ports)
VMD Controller 3	Front NVME 0-1 (2 ports)
VMD Controller 4	Front NVME 2-3 (2 ports)

Boot is supported for RAID arrays attached to Intel VMD controllers this generation. RAID arrays can be spanned across Intel VMD controllers, but boot is not supported on those arrays. It is not recommended tospan RAID arrays across the Intel VMD controllers on different CPUs.

3.2 Broadcom MegaRAID SAS controllers

To install and use SAS drives and expand storage to the maximum number of drives, Broadcom MegaRAID SAS controllers are required. MegaRAID SAS 9540-8i and MegaRAID SAS 9660-16i have been validated with the platforms and are offered as a factory install option.

MegaRAID SAS 9540-8i is an Integrated MegaRAID (iMR) controller with minimal resources compared to the MegaRAID SAS 9660-16i which is a full MegaRAID RAID on Chip (ROC) controller. The table below compares the major features between these two controllers.

Table 4 Broadcom MegaRAID controller basic feature list

Feature	MegaRAID SAS 9540-8i	MegaRAID SAS 9660-16i
Number of Phys	8	16
Max SAS/SATA drives supported	8	16
Max NVMe drives supported	2 (x4 NVMe)	4 (x4 NVMe)
HW ROC (RAID on Controller)	No	Yes
SuperCap – Cache Backup	Not applicable	Yes
Limitations in Legacy OROM mode	Yes	No
Performance and number of Outstanding IOs	Low	High

3.3.1 Legacy BIOS Configuration Utility – No support

Unlike the previous generation of Broadcom MegaRAID SAS controllers, Configuration utility (Ctrl-C) in Legacy BIOS mode is not supported anymore. To install an operating system in Legacy BIOS mode, you must switch to

UEFI mode and use the UEFI-HII utility to create RAID volumes as shown in this document. Then, switch the mode back to Legacy BIOS mode to install OS. The RAID volumes created in UEFI Mode are persistent and are usable in Legacy BIOS as well.

Note: Installing operating sytem in UEFI mode, will partition the drive to GPT mode. If you switch the boot mode to Legacy after installing the operating system, your operating system will not be bootable. Because legacy BIOS expects the operating system to be installed on an MBR partition. Remember to use right

3.3.2 Profiles and NVMe support

Broadcom RAID controllers support SAS, SATA, and NVMe drives. However, at the time of this writing, SAS/SATA and NVME cannot be supported simultaneously. The drive type support is set by the profilechosen for the card. For example,

- Profile ID#40 is the default and supports SAS/SATA only.
- Profile ID#41 can support NVMe.

The Profiles cannot be switched dynamically. The system needs to be rebooted every time after the profile ischanged, for the new profile to take effect.

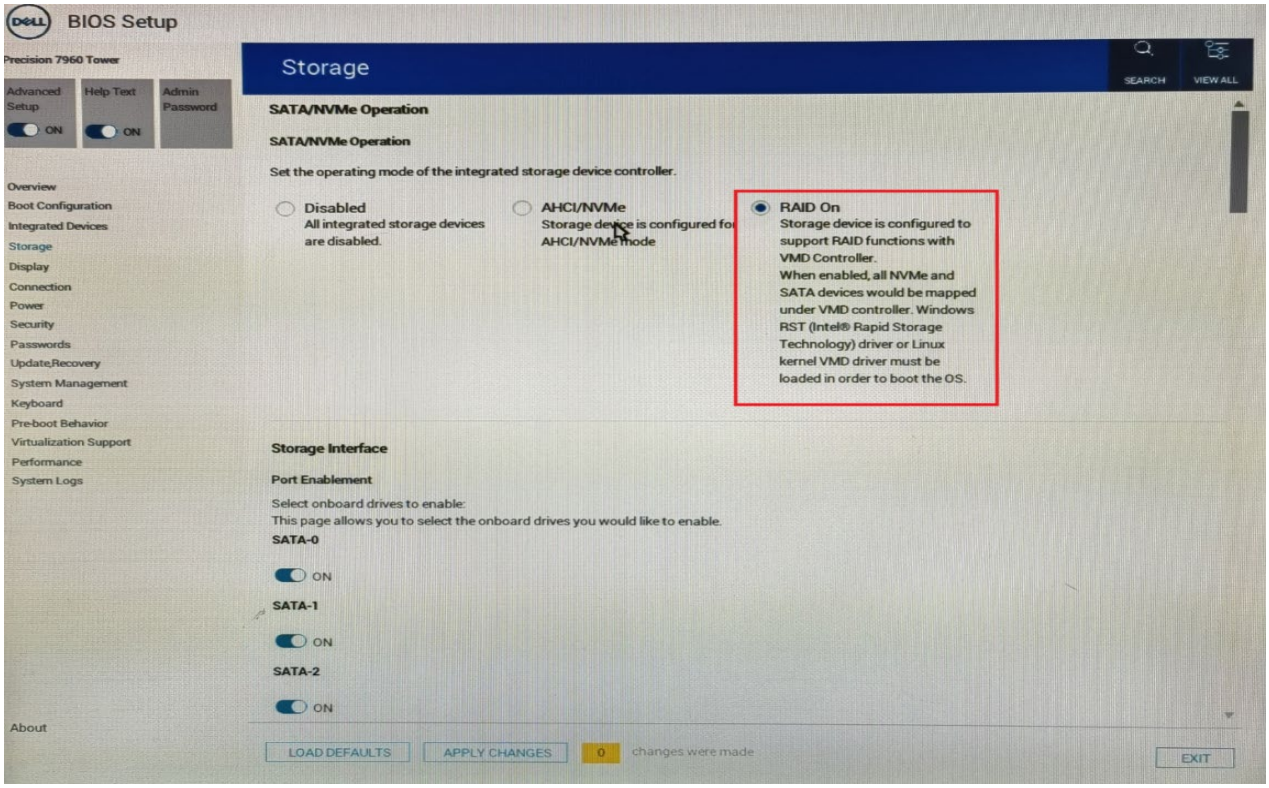
Note: When you choose Profile ID 41 to support NVMe device, system cannot change back to Profile ID 40 again even if system configuration change to SAS/ SATA drive.

4 Configuring RAID with Intel VROC

The Intel VROC is used to configure RAID volumes on NVMe drives connected to Onboard PCIe slots. It is only available in UEFI boot mode. This feature needs a VROC key to be installed, and it is available when Intel VMD technology is enabled in system BIOS setup.

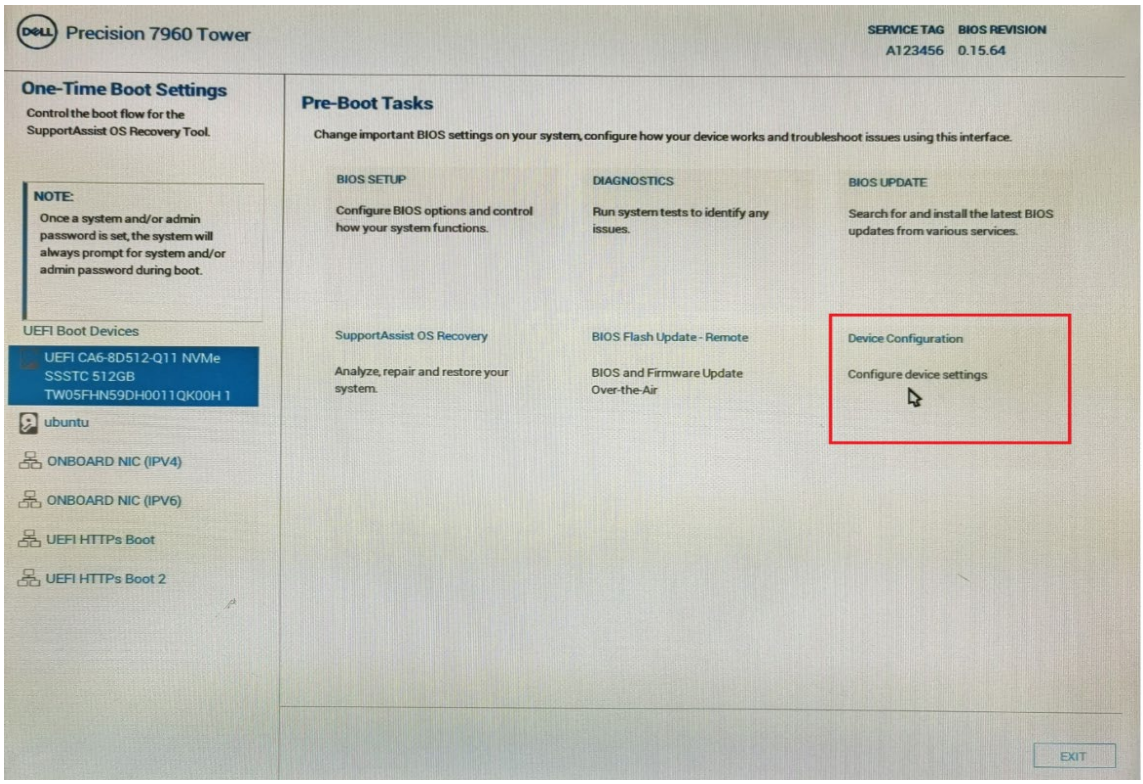
4.1 Enabling Intel VMD Technology

To enter BIOS setup, we can either press F12 during POST and then select BIOS Setup or press F2 to go directly to the BIOS settings. In the BIOS settings, then select the Storage menu. In the menu, click RAID On as shown below. Make sure to apply the new setting before you exit the BIOS setup. After exit the BIOS setup menu, the system will reboot and then we can continue to create the RAID volume.

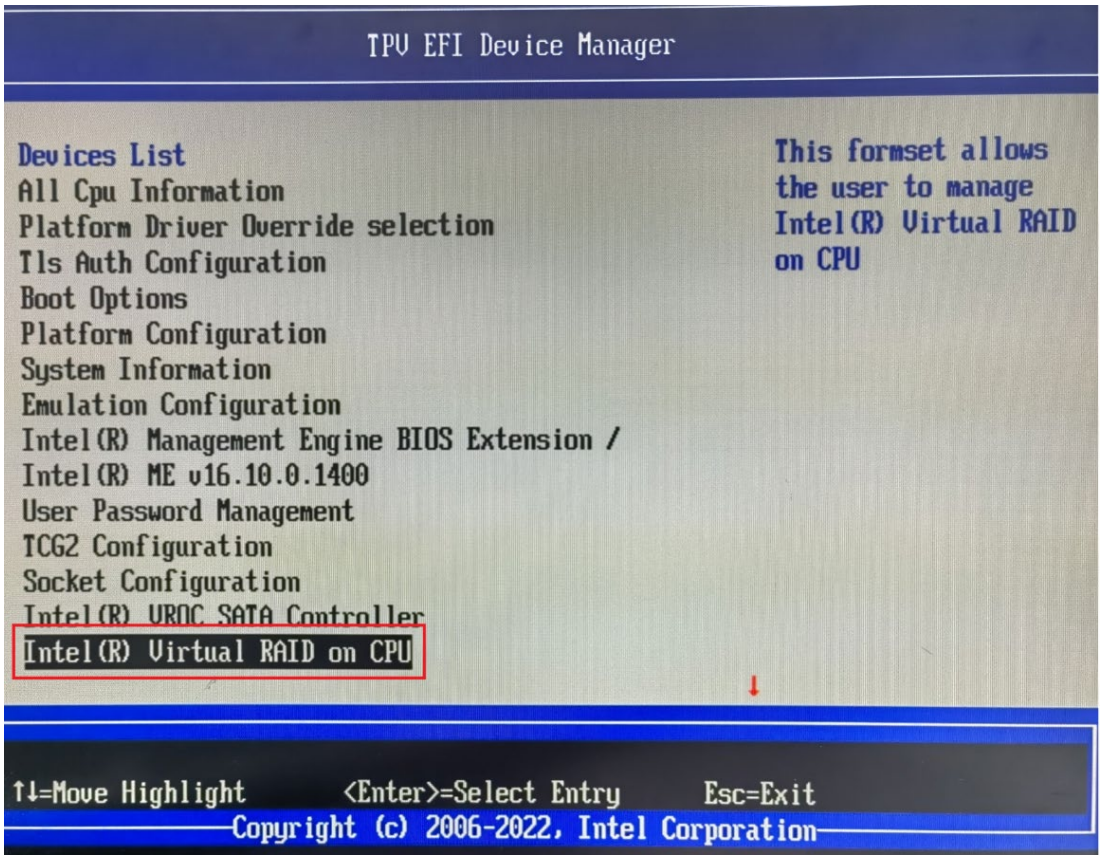


4.2 Creating a RAID Volume

Entering the one-time Boot Options menu: During system POST, press the F12 menu when the Dell logo is loading. You will see a progress bar appear if your keystroke was successful. You will now be presented with a menu like the below.

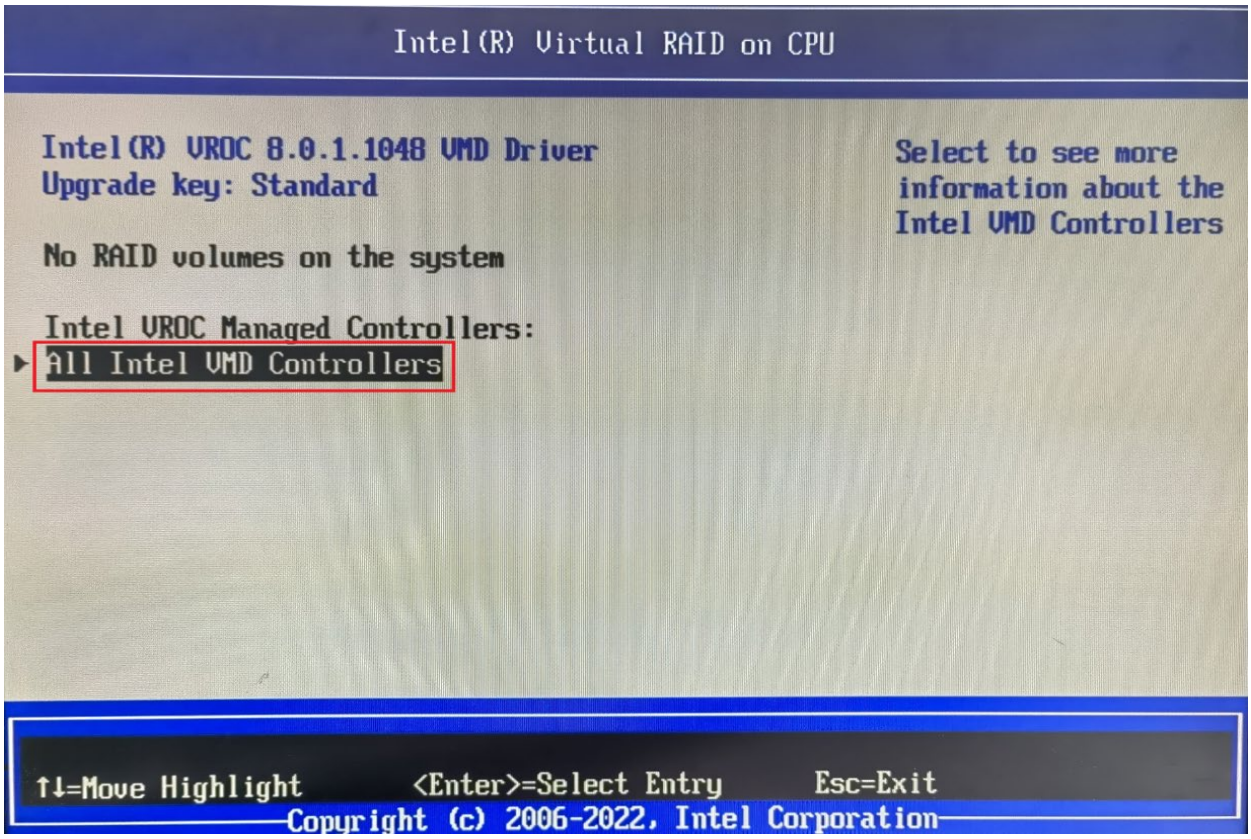


Entering the Device Configuration Utility: Using the ↑ and ↓ arrow keys, navigate to Device Configuration, and press the ENTER key on your keyboard. Depending upon the devices you have installed in the system, you may be presented with different options than the below. You can use the left and right arrow keys to navigate to the different devices you have installed in the system. Select the **Intel Virtual RAID on CPU** tab as shown below.

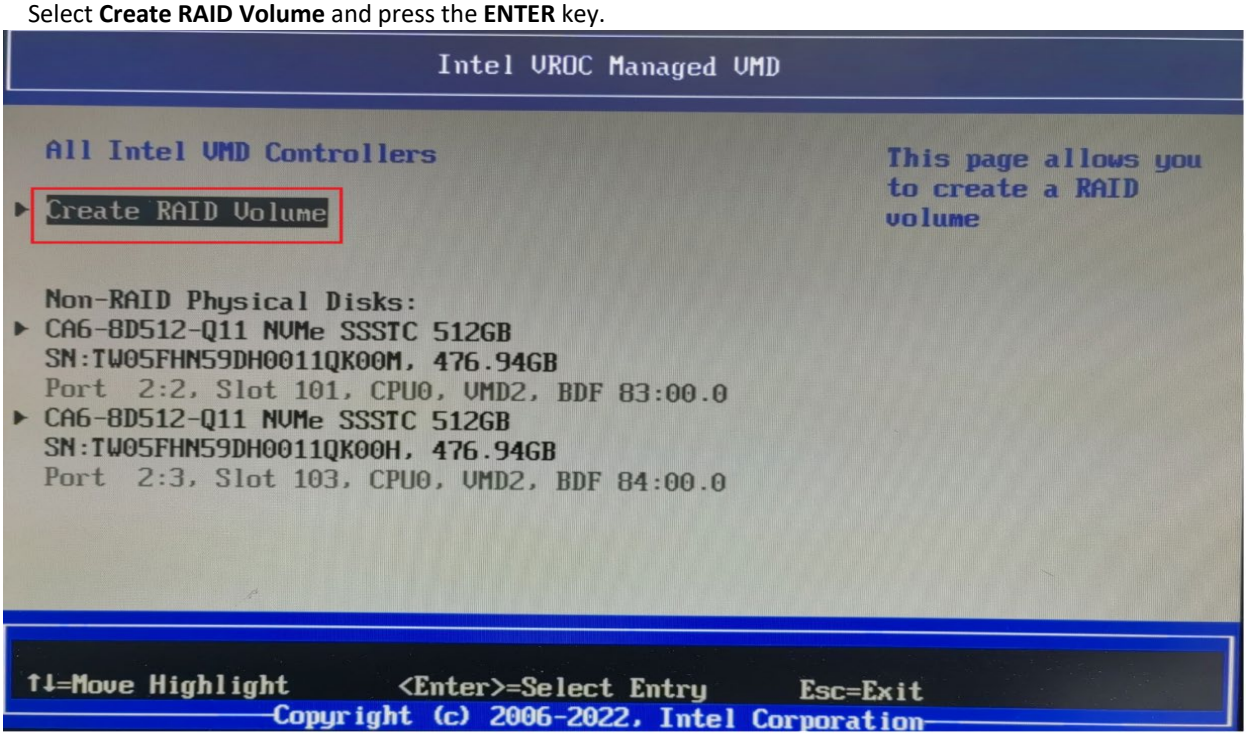


Navigation within the Device Configuration Utility: Once inside the Intel Virtual RAID on CPU the user cannavigate around using the up (↑) and down (↓) arrows on the keyboard. ESC can be used to exit the device and return to the Boot Options Menu. ENTER is used to select the currently highlighted menu option. These options are also described at the bottom right-hand corner of the screen.

Creating a RAID Volume: Navigate to **All Intel VDM Controllers** and press the **ENTER** key. You will be presented with the below screen.



Select **Create RAID Volume** and press the **ENTER** key.

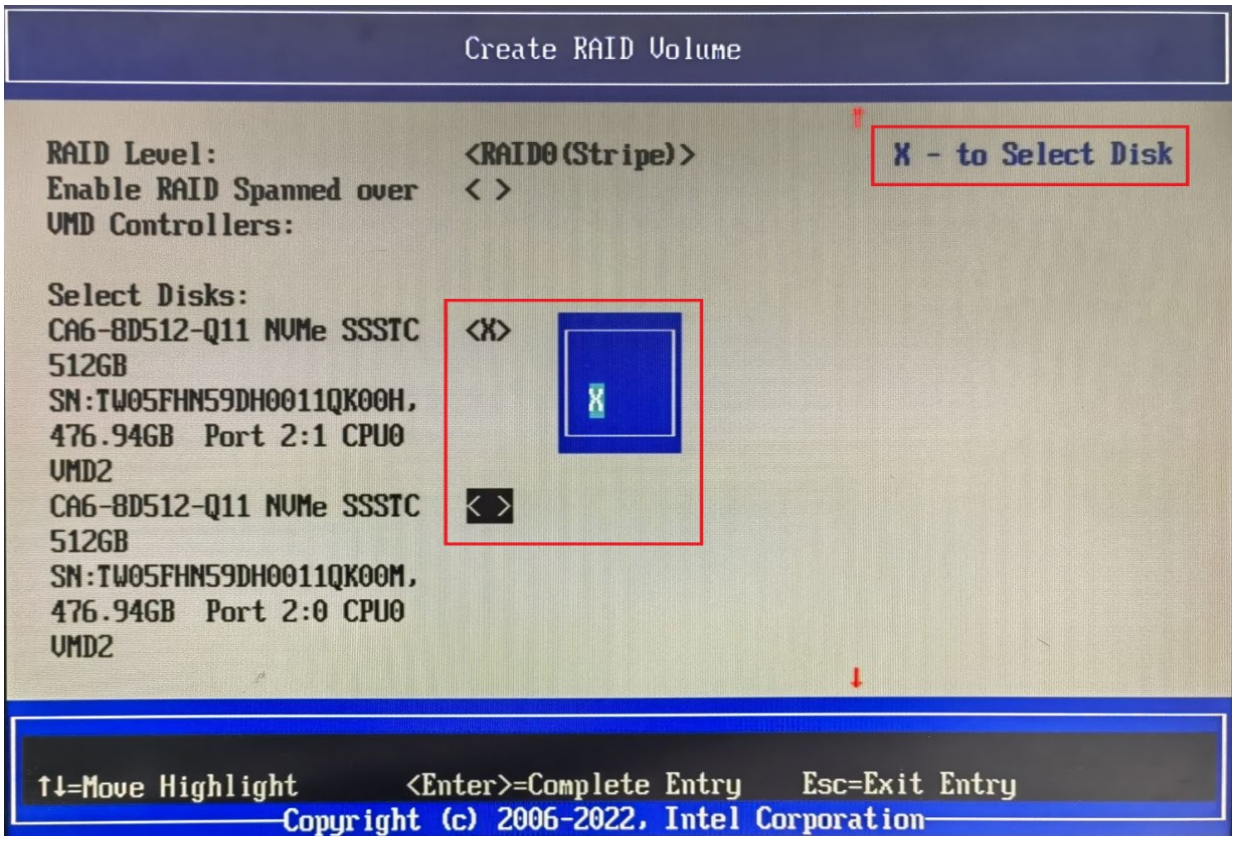


Name the RAID Volume: The first step is to provide a name for the RAID Array. This can be an alpha- numeric name with no more than 16 characters. Once completed, press the down arrow to go to the next step.

Choose a RAID Level: The next step is to choose the RAID level that you plan to configure. Use the + and — keys on the keyboard to select different options. Once the desired RAID level is chosen, press TAB togo to the next step.

Note: Depending on the number of drives attached to the system, the RAID options may be limited. RAID0 requires a minimum of two drives. RAID1 is limited to two drives. RAID5 requires a minimum of three drives.

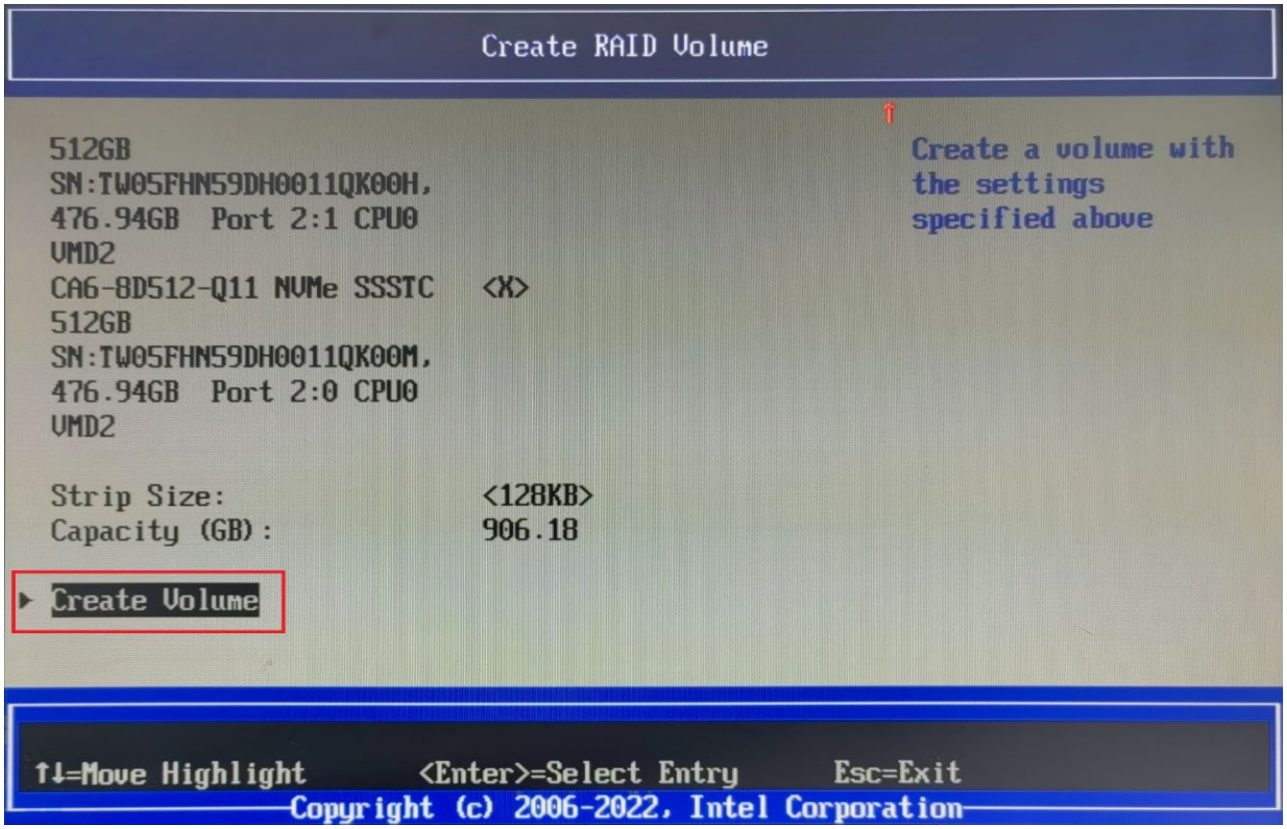
Select Disks: The next step is to select the disks that is used within this volume. Using the Up and Down arrow keys, you can navigate to the different disks. Use the + and — keys to select (+) or deselect (--) a drive as a member disk for the RAID volume.



Note: A small X will appear next to the drives that you have selected as shown above. Drives already a part of an existing volume will not appear in this list. You will need to delete the existing volume if you plan to use those drives within a new RAID volume.

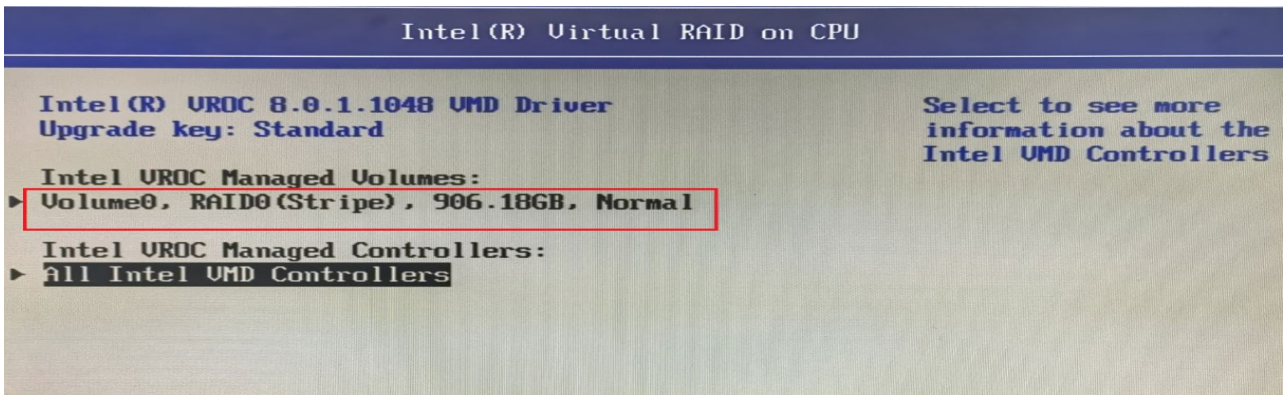
Choose Strip Size and Capacity (Optional): Strip size can be adjusted depending on the usage scenario.This is entirely up to the user on the strip size that might provide the most benefit to your usage model. The capacity section of this menu is automatically populated with the maximum capacity available based on the combination of RAID Level chosen, and the actual drive capacity. This can be adjusted if the user desires.

Create Volume: Once the above steps have been completed, press down key again to navigate to the **Create Volume** option as below.



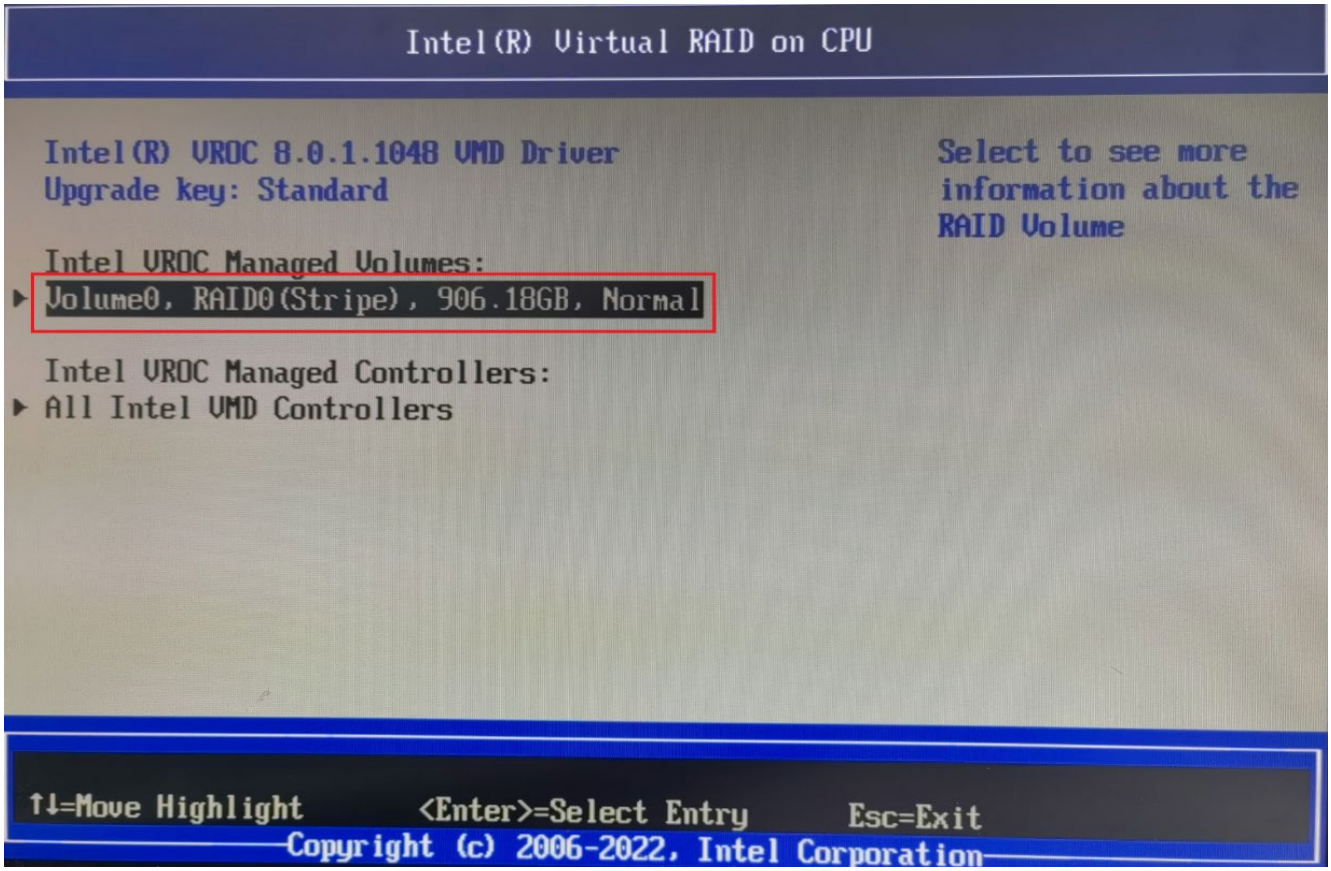
Press **ENTER** to select this option.

Completion: You will now be taken back to the home page. If your RAID volume was created successfully, you should see the RAID volume appear in the list, and the drives included in the RAID volume are no longer present within the Non-RAID Physical Disks list. Please see below, for a simple RAID0 built from two 512 GB NVME drives.

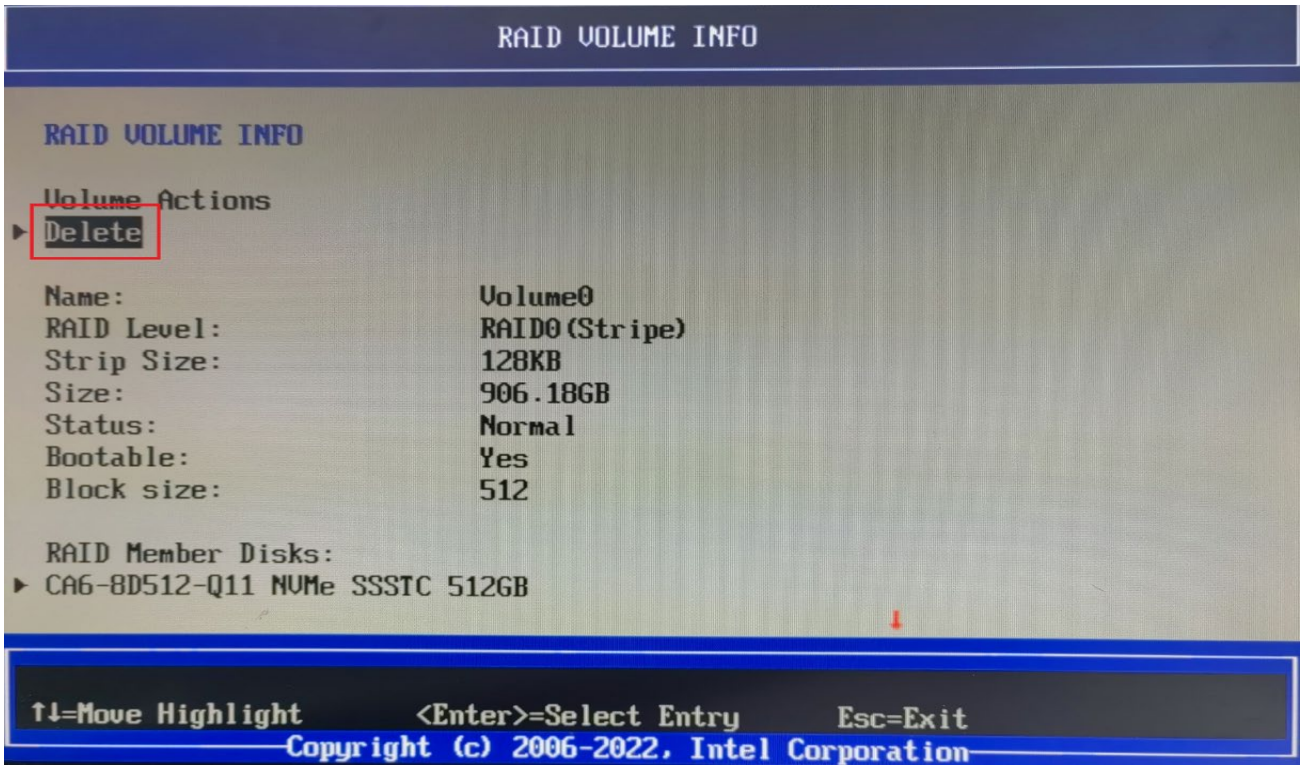


4.3 Deleting a RAID Volume

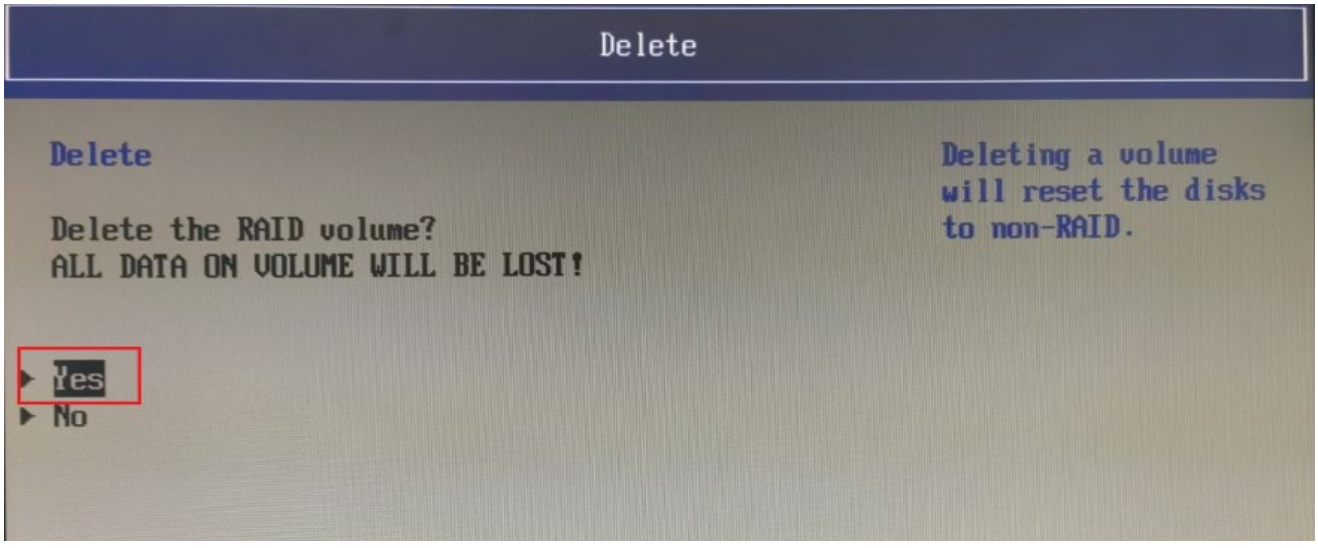
Choosing the right RAID Volume: Enter the Device Configuration menu as shown in the Creating a RAID Volume step. While in the Device Configuration menu, you can navigate using the Up and Down arrow keysto get to additional information on the various RAID volumes. Once you have the RAID volume selected you would like to delete, press the Enter key on your keyboard.



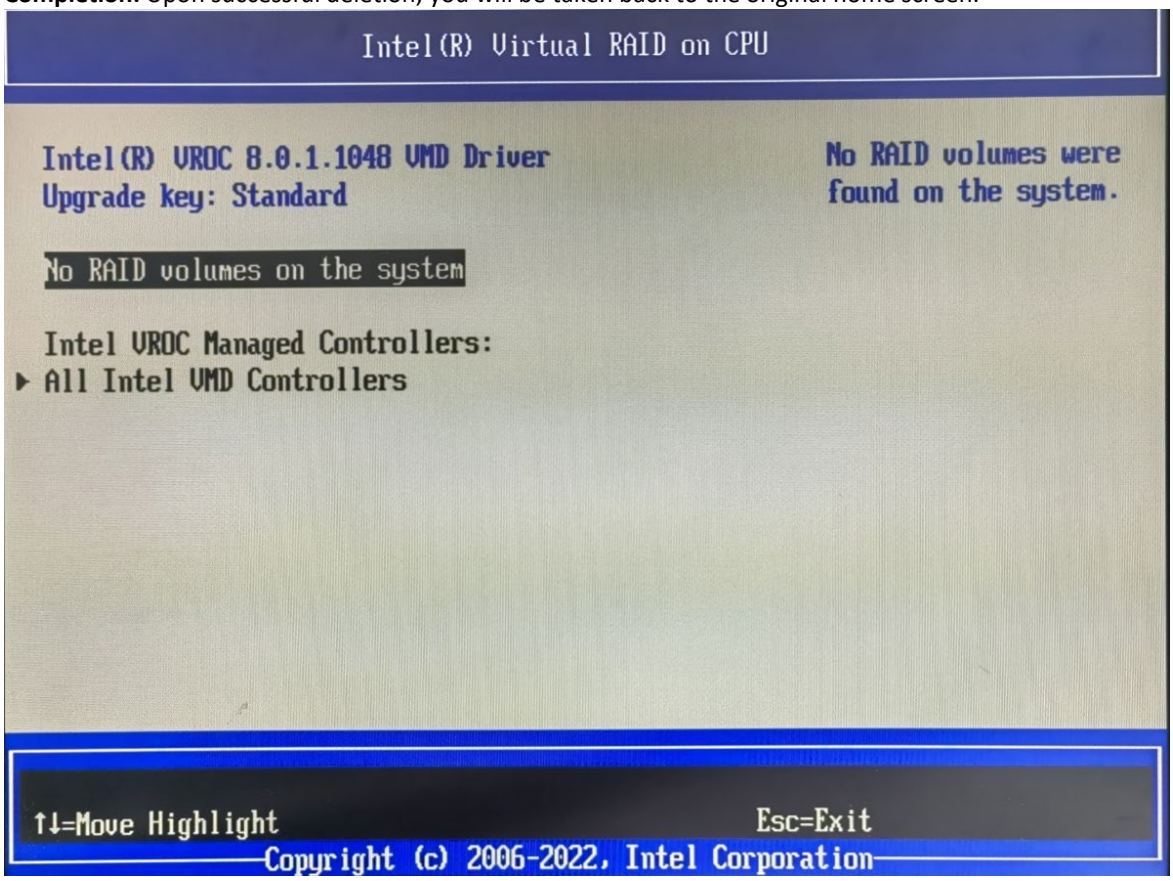
Delete Volume: You will now be presented with the below screen. Use the ↑ and ↓ arrow keys again to navigate to different options within the menu. You can also select the individual disks and press **Enter** to see additional information on the disks. Once you are ready to delete the volume, navigate to the **Delete** option as below, and press **Enter** on your keyboard.



Confirmation: There is a confirmation step prior to deletion to confirm. All data on the disks will be deleted upon completion of this step. If you are certain you would like to proceed, navigate to Yes using the up and downarrow keys, and press **Enter**.



Completion: Upon successful deletion, you will be taken back to the original home screen.



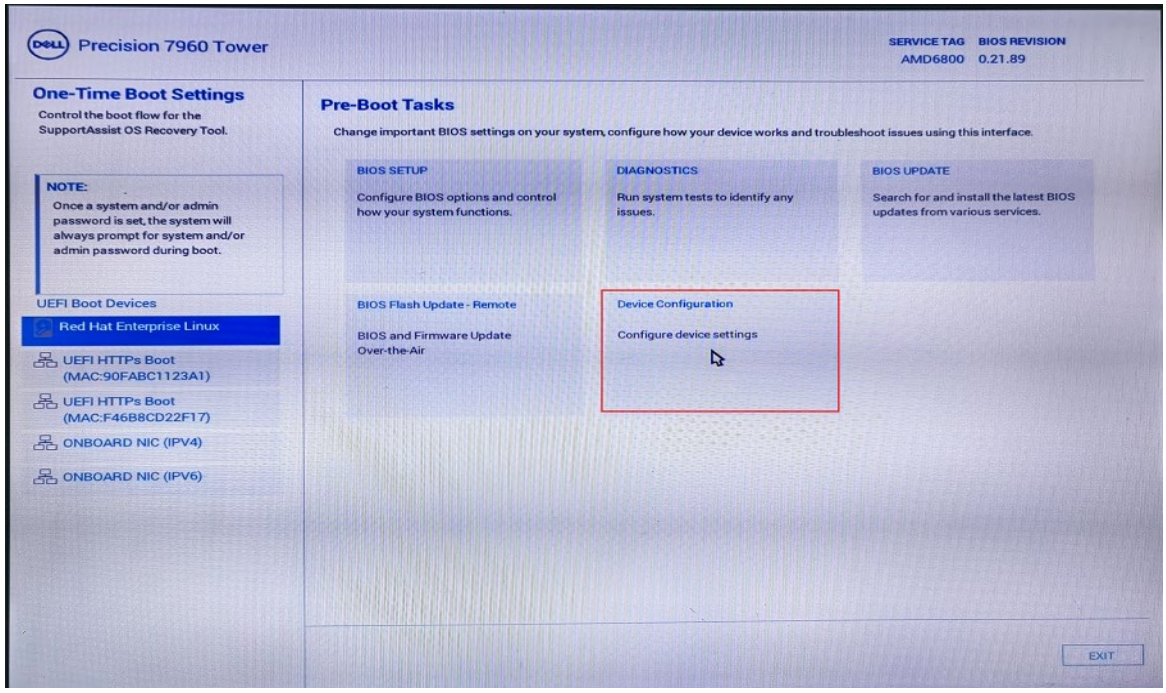
5 Broadcom MegaRAID 9540-8i and 9660-16i Controllers

In this current generation Configuration utility in Legacy BIOS mode is de-featured. And so, the user needs to use UEFI-HII Configuration utility to do RAID configurations with Broadcom MegaRAID 9540-8i and 9660-16icontrollers. After successfully creating the RAID volumes, user is free to use either legacy BIOS mode or UEFI boot mode.

Note: Avago is the previous name for Broadcom and may still appear in some of the tools. The names Avago and Broadcom may be used interchangeably in this document.

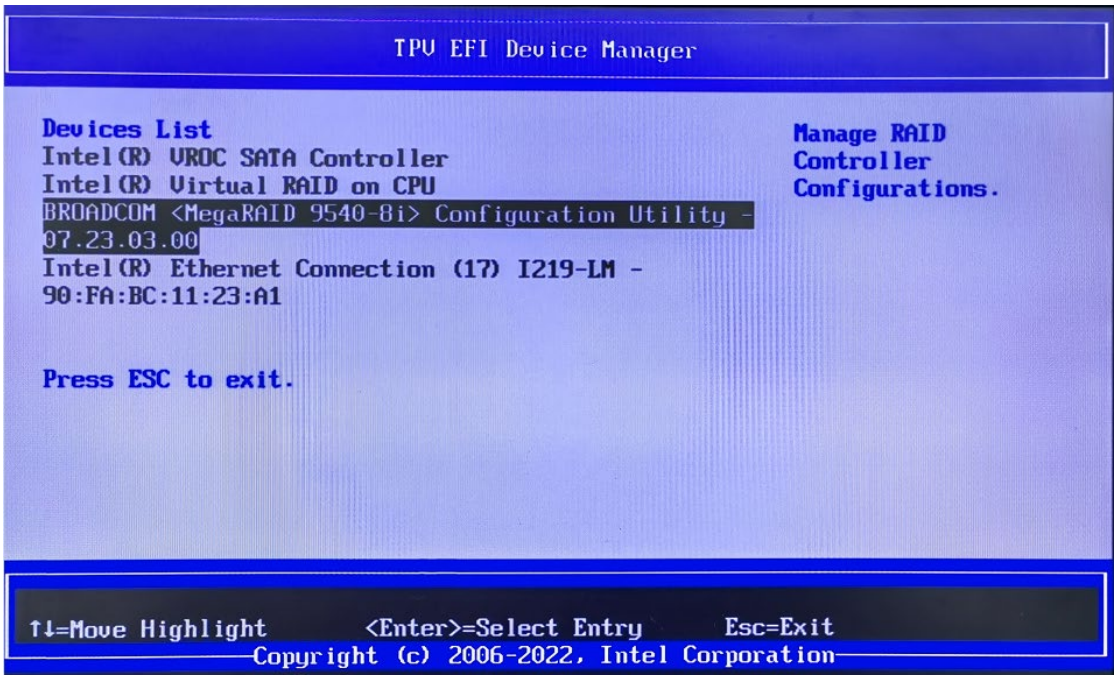
5.1 Creating a RAID Volume

Enter the Device Configuration Menu: During system POST, press the F12 menu when the Dell logo is loading You will see a progress bar appear if your keystroke was successful. You will now be presented with a menu similar to the below.

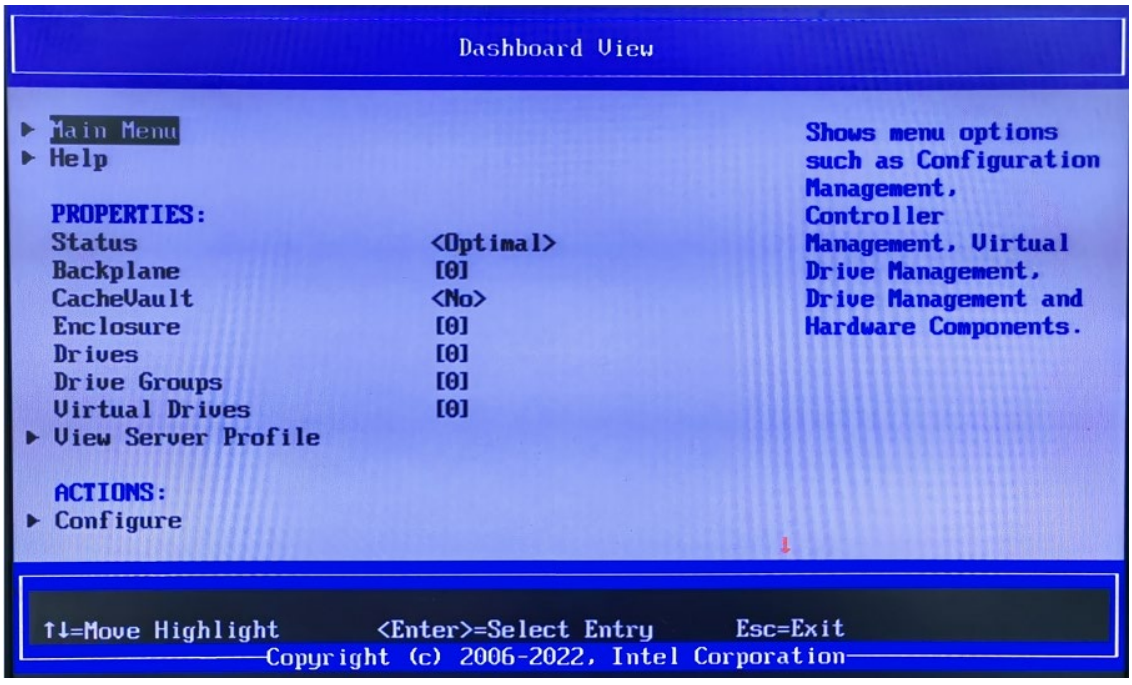


Using the ↑ and ↓ arrow keys, navigate to Device Configuration, and press the ENTER key on your keyboard. Depending upon the devices you have installed in the system, you may be presented with different options than the below. You can use the left and right arrow keys to navigate to the different devices you have installed in the system.

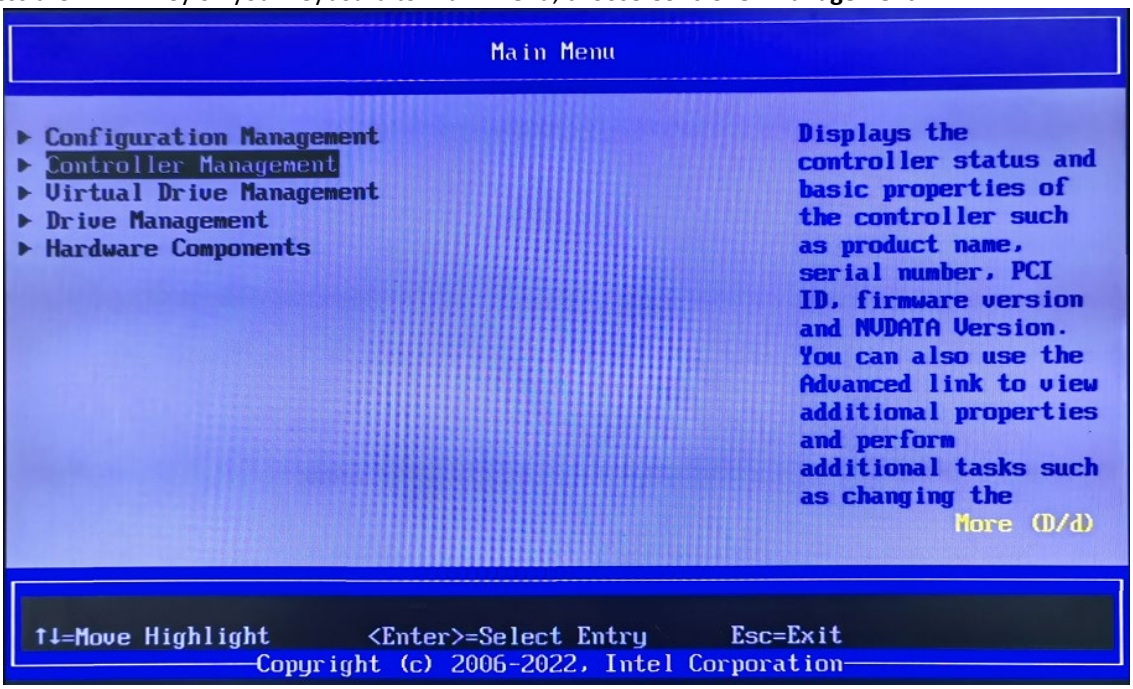
Select the UEFI-HII configuration utility for Broadcom RAID controllers: Once inside the MegaRAID Configuration Utility the user can navigate around using the up (↑) and down (↓) arrows on the keyboard. ESC can be used to exit the device and return to the Boot Options Menu. ENTER is used to select the currently highlighted menu option. These options are also described at the bottom right-hand corner of the screen.



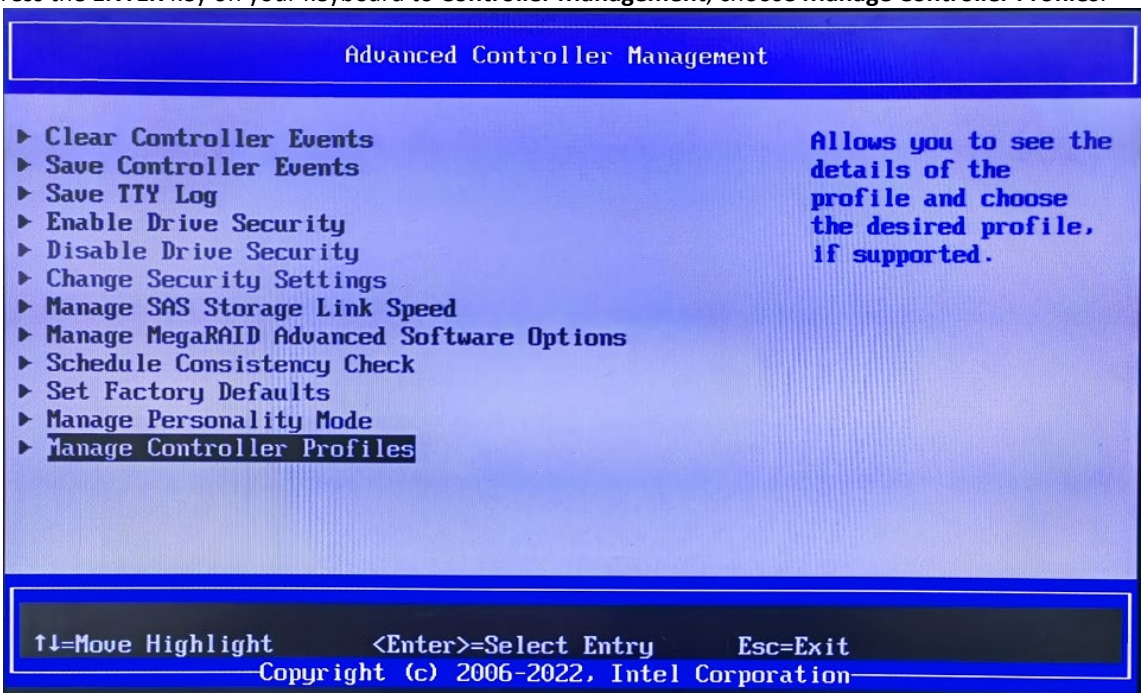
Choose Profile: Before the RAID created, you must choose Profile ID base on storage type (Profile ID 40 Support SAS/SATA, Profile ID 41 Support SAS/SATA/NVMe). At Device Manager Choose BROADCOM <MegaRAID 9540-8i> and press the ENTER key on your keyboard to Main Menu:



Press the **ENTER** key on your keyboard to **Main Menu**, choose **Controller Management**:

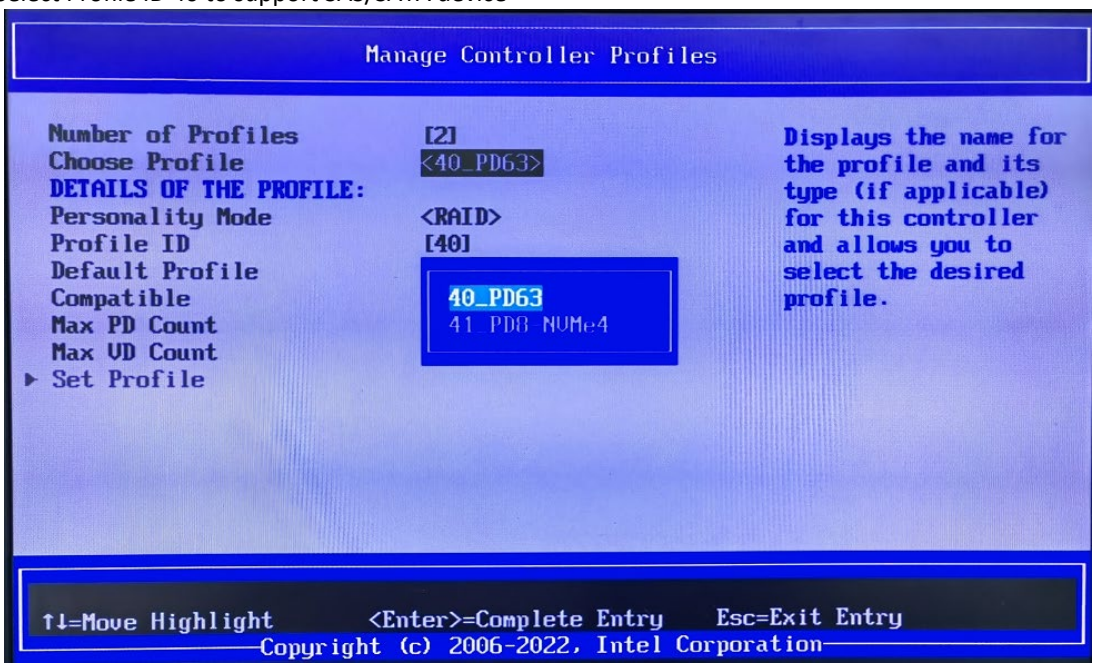


Press the **ENTER** key on your keyboard to **Controller Management**, choose **Manage Controller Profiles**:

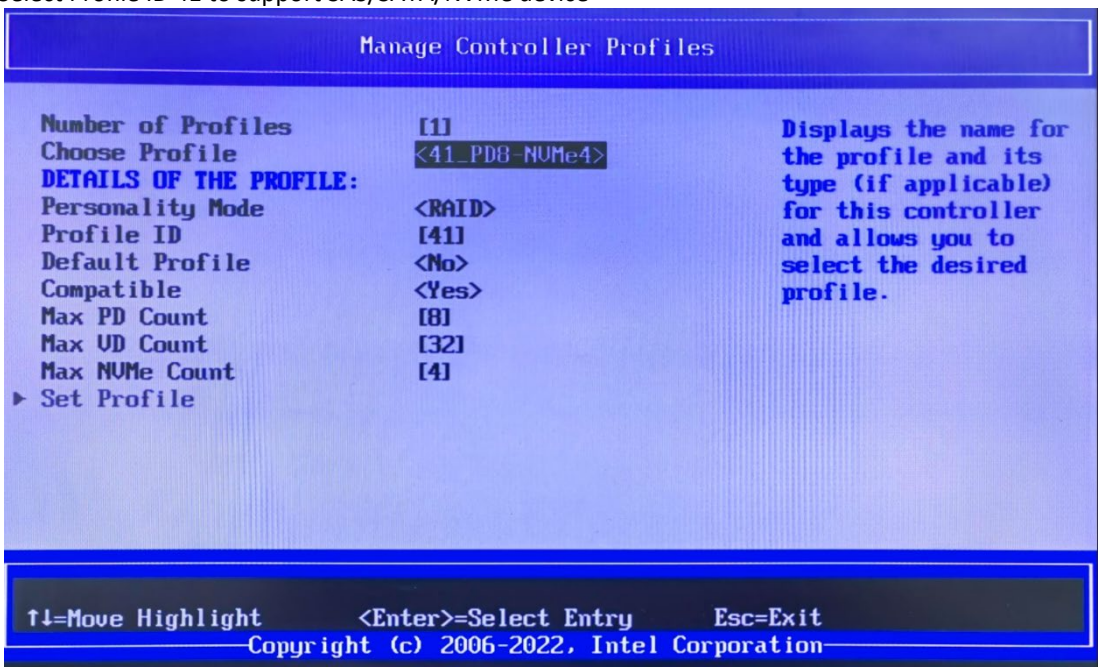


Press the **ENTER** key on your keyboard to **Manage Controller Profiles**, to choose Profile ID base on storage type, then choose **Set Profile** to save change.

Select Profile ID 40 to support SAS/SATA device

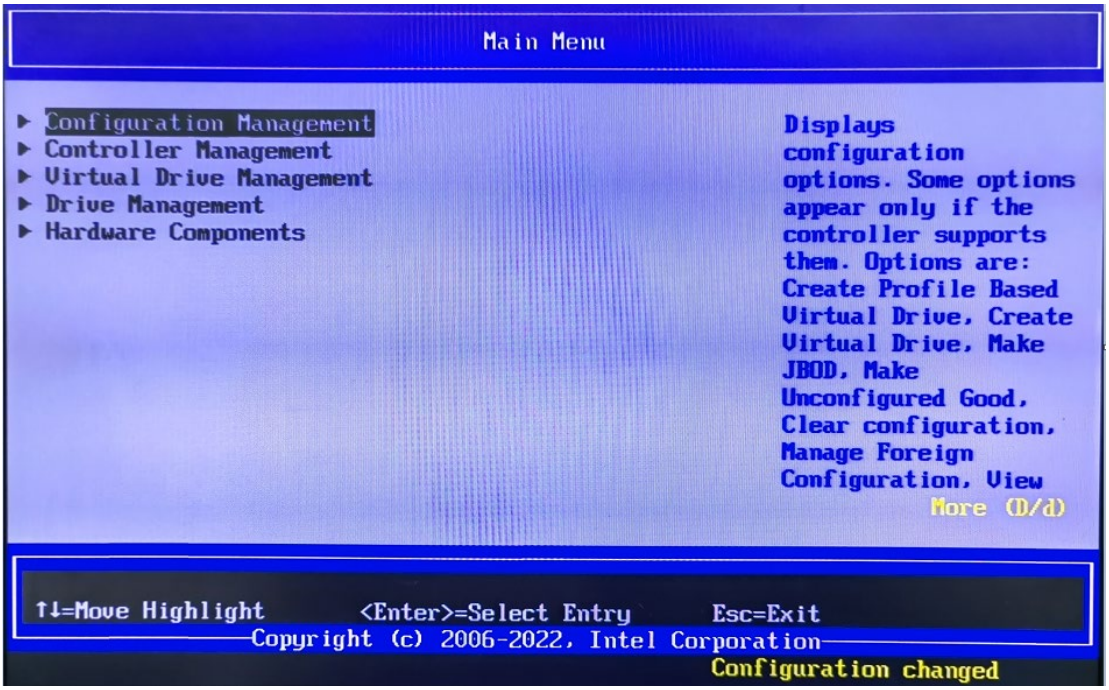


Select Profile ID 41 to support SAS/SATA/NVMe device

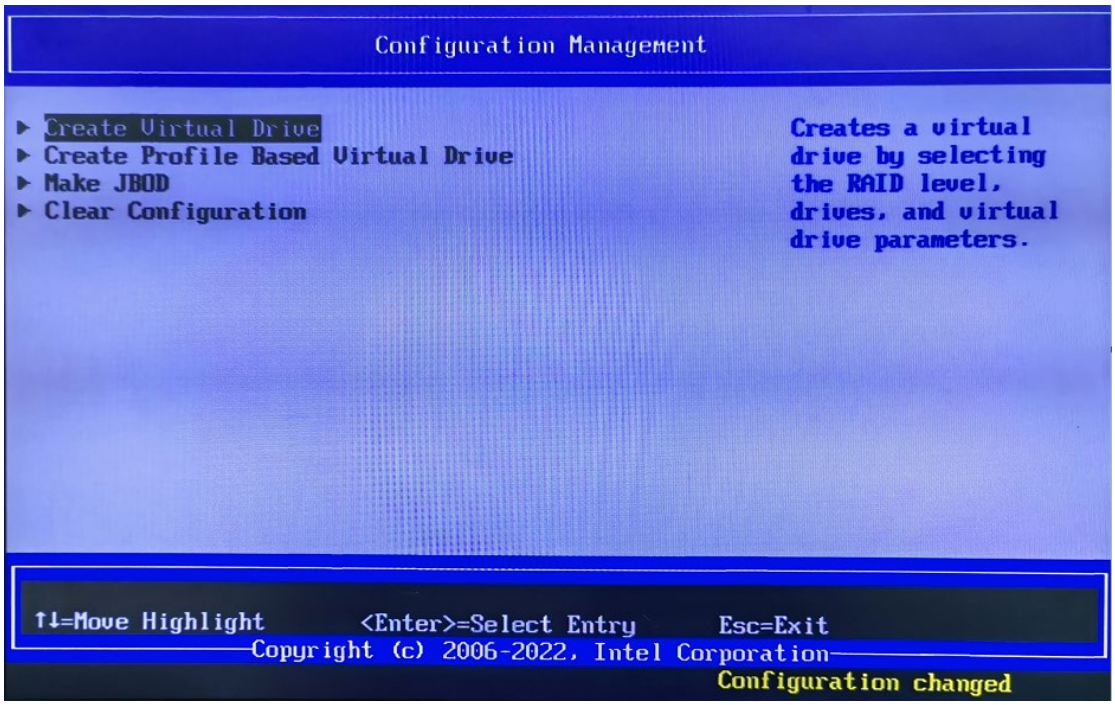


Note: When you choose Profile ID 41 to support NVMe device, System cannot change back to Profile ID 40 again even if system config change to SAS/ SATA device.

Creating the RAID Volume: When you are ready to create a RAID Array or Virtual Drive, navigate to where Configuration Management is highlighted, and press Enter. You will now be presented with the below menu.

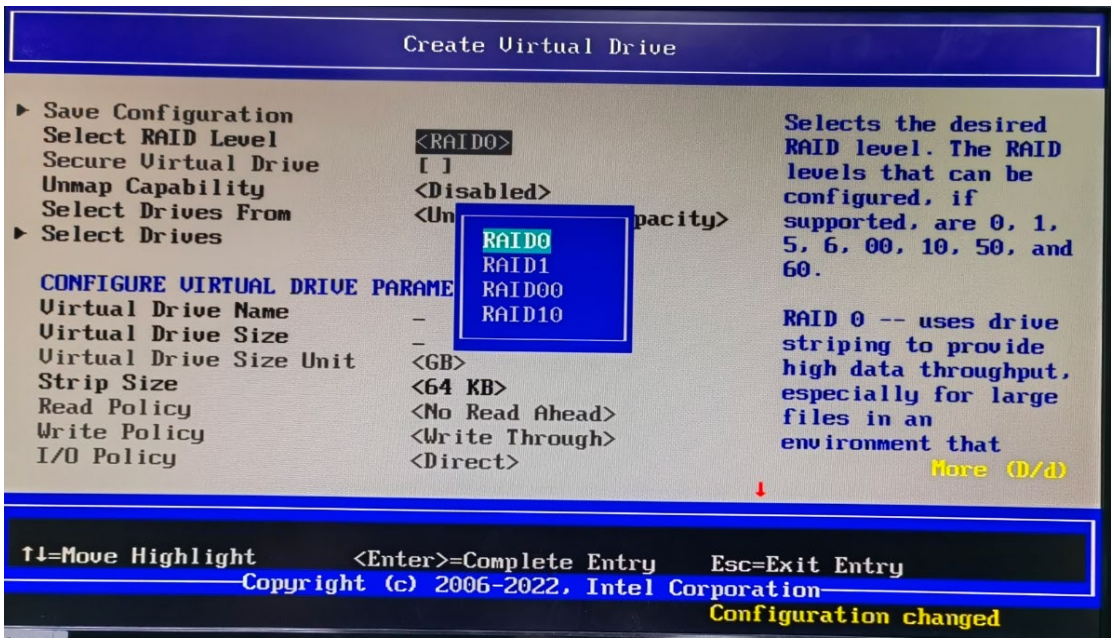


Press Enter again (Create Virtual Drive) to begin setting the RAID array.

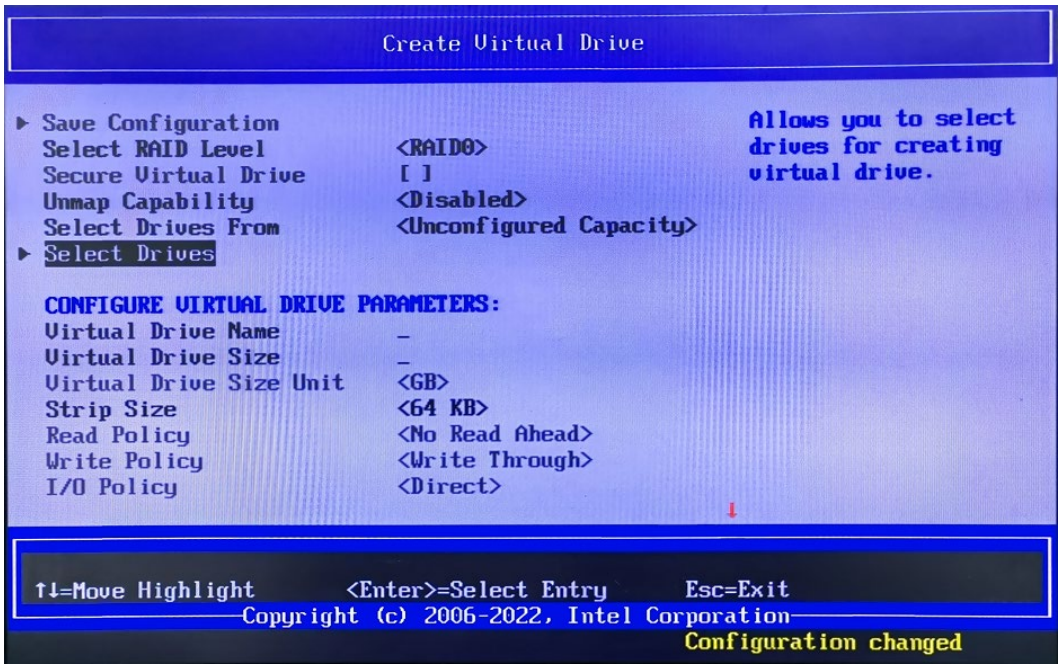


Choosing a RAID Level: The first step to creating a RAID array is to choose the RAID level desired. You can either use the +/ -- keys on the keyboard to change the RAID level, or press Enter to bring up a list of supported RAID options based on the HDD's available in the system. On this same page, you can use the upand down arrows to navigate down to other options that will be different based on a given use case. We will proceed with using the default options. When ready, navigate up to highlight the **Select Drives** option and press Enter.

Note： Please refer to 5.1.1 for RAID 10 Create.

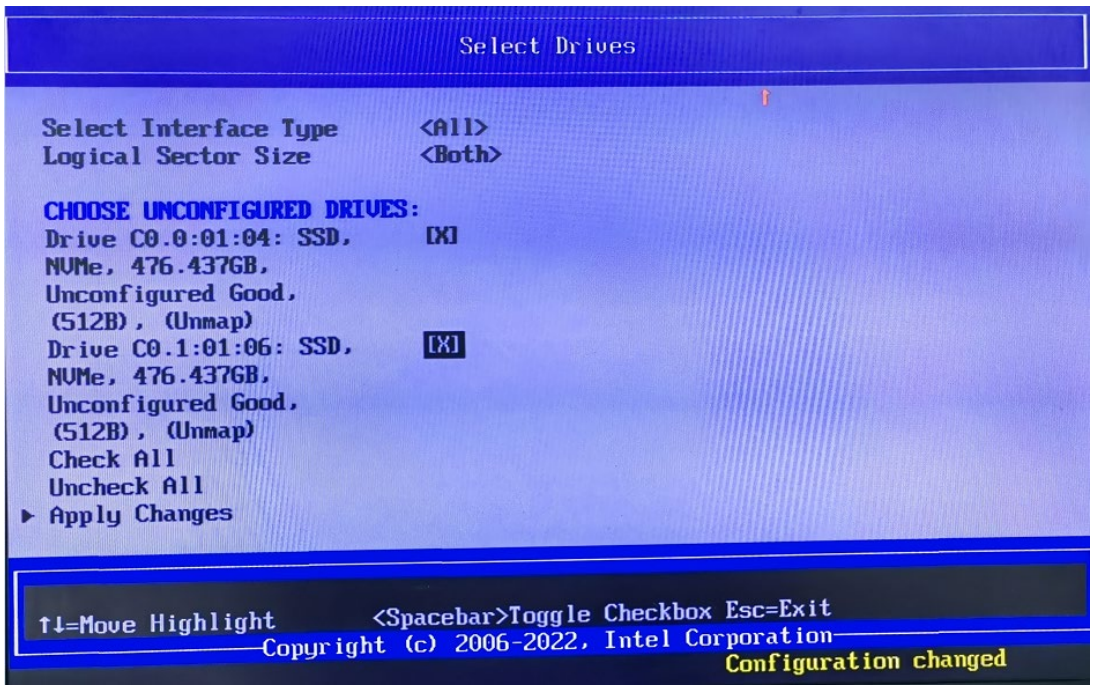


Selecting Disks: You will now be presented with a screen similar to the below. Select Media Type allows you to choose which types of drives are displayed in the list. Select Interface Type allows you to choose which types of interfaces will be shown, either SATA, SAS, or both. Logical Sector size allows you to limit only showing 512 GB or 4k-Native drives, or both.

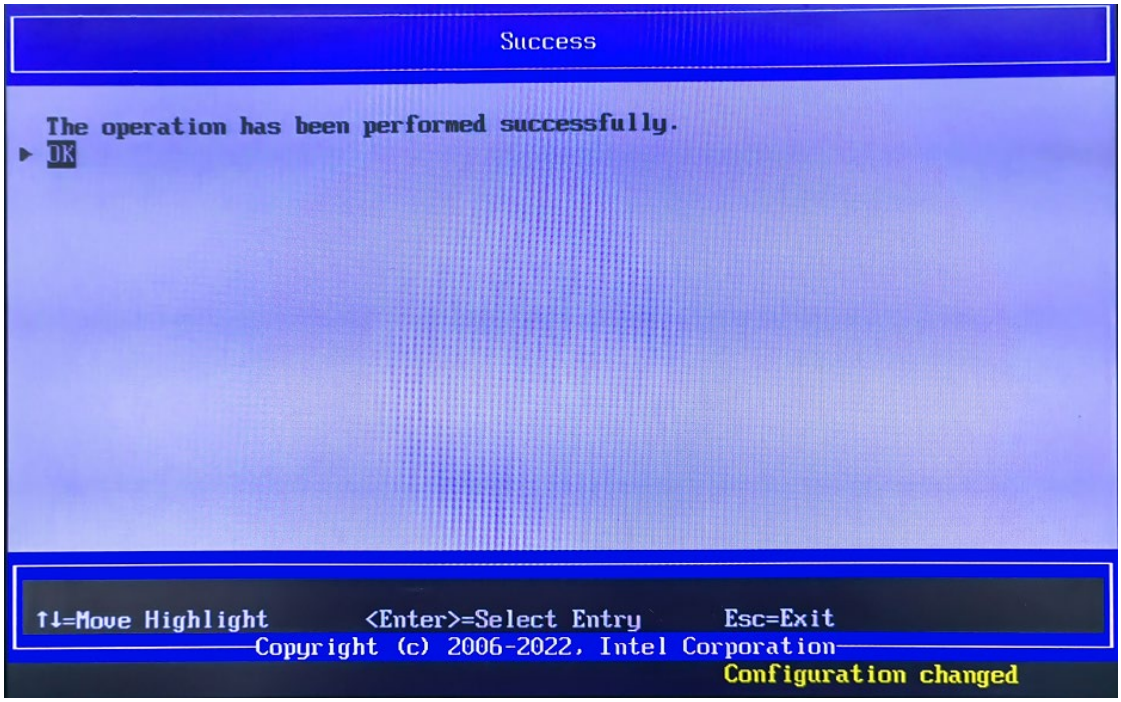


To select your drives, navigate down to the Unconfigured drive list. Navigate to each of the drives that you would like to include in your RAID array and press the Enter key to select that drive. You can also press the +key while the drive is highlighted to select it, or the — key while a drive is highlighted to deselect that drive.

When finished, navigate down to the bottom of the list, **Apply Changes**, and press the **Enter** key.



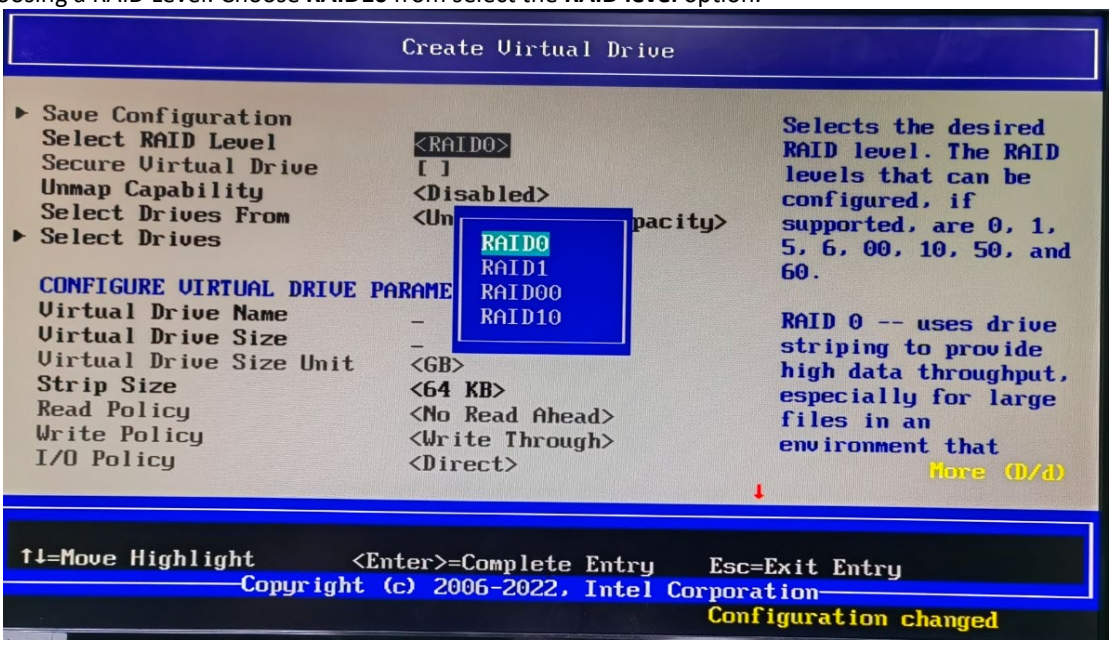
Saving Configuration and Confirmation: You will now be back at the previous menu. From here, navigate to Save Configuration and press the Enter key. At this point, you will be presented with a final warning that creating the drive will cause all data to be lost. Press the Enter key and enable the Confirmation button.
Alternatively, you can use the + key to enable the confirmation button. Use the arrow keys to navigate to **Yes**, and press **Enter** again. Your RAID array is created and initialization begins.



5.1.1 Creating a RAID10 Volume

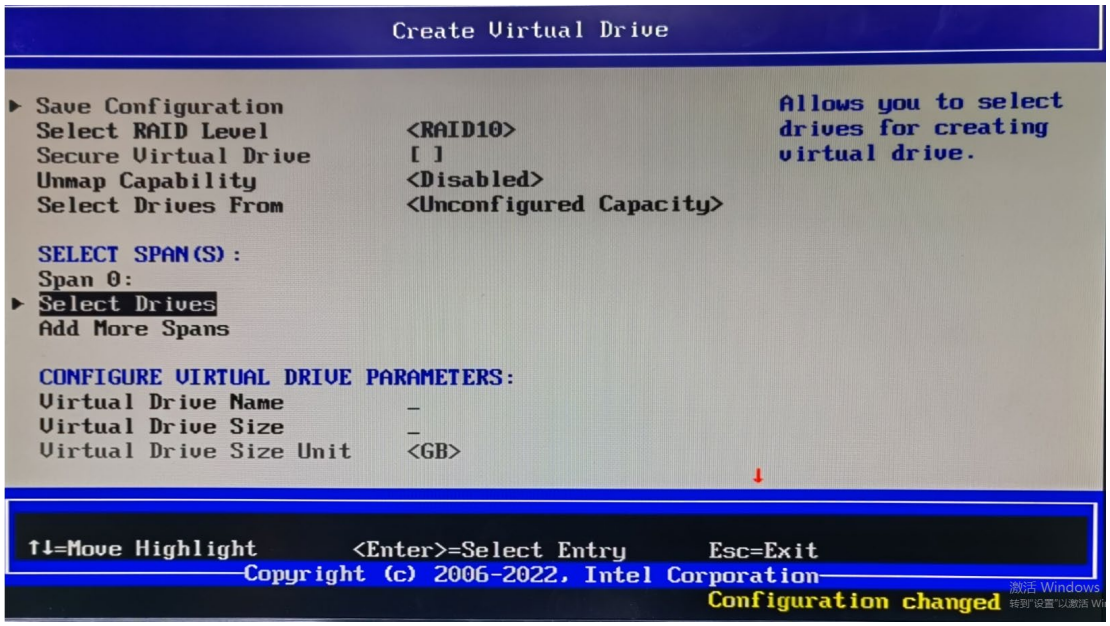
RAID10 is a spanned volume and so it requires additional steps to create a RAID10 compared to other volumes. The additional steps are shown below for an example of creating a RAID 10 volume from 4x 2 TBdrives.

Choosing a RAID Level: Choose **RAID10** from select the **RAID level** option.

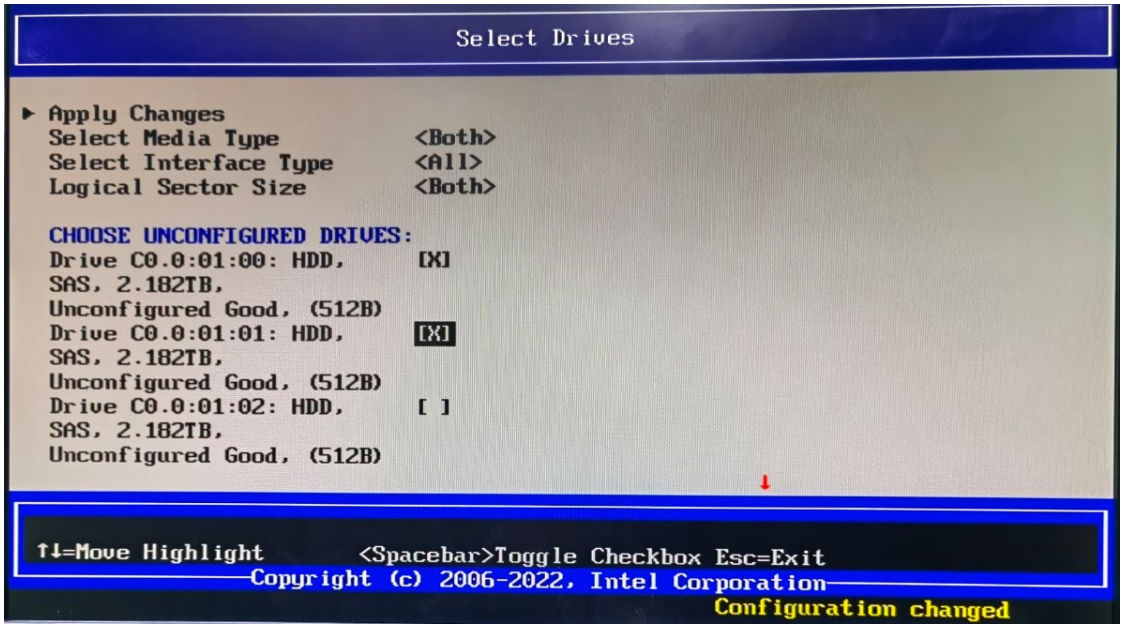


Select Spans: As RAID10 is a spanned virtual drive, we need to add multiple spans. For a 4 drive RAID10, you need 2 spans of RAID1. Select **Add More Spans** to create two spans.

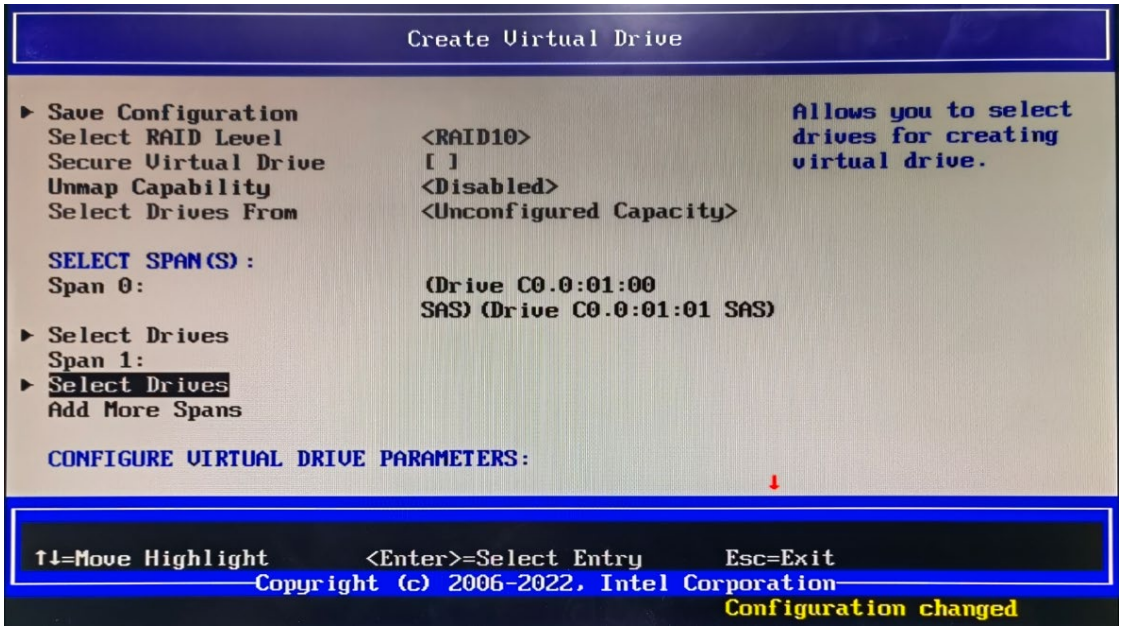
Then we will select drives for each span as shown below.



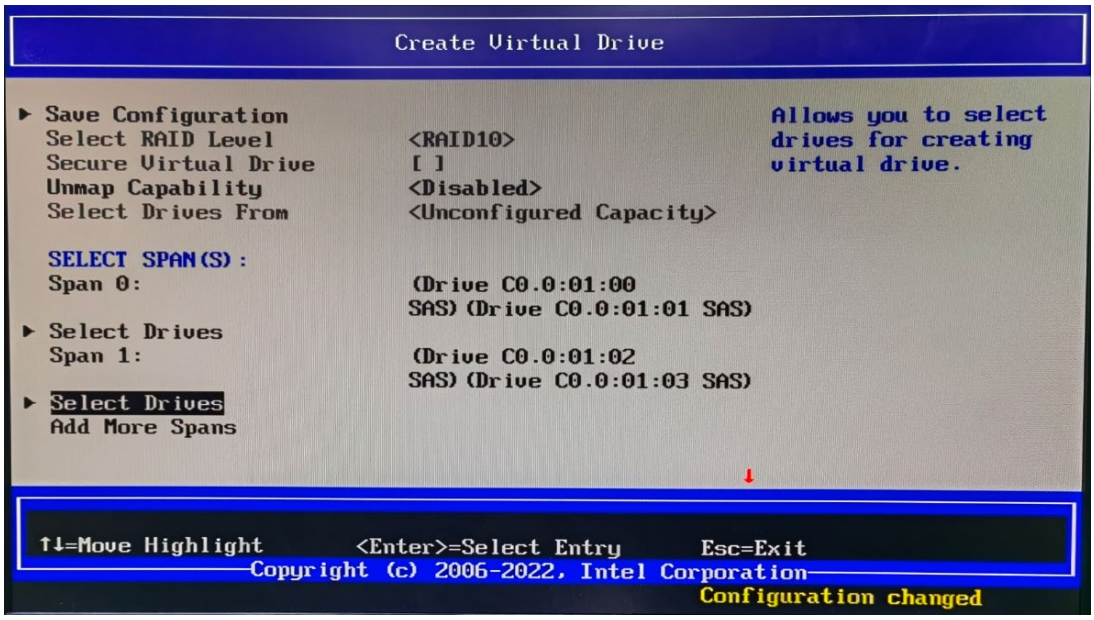
Selecting Drives for Span 0: When we press enter with the **Select Drives** highlighted for span 0, we can choose from the Unconfigured drives shown. For this example, two drives are selected.



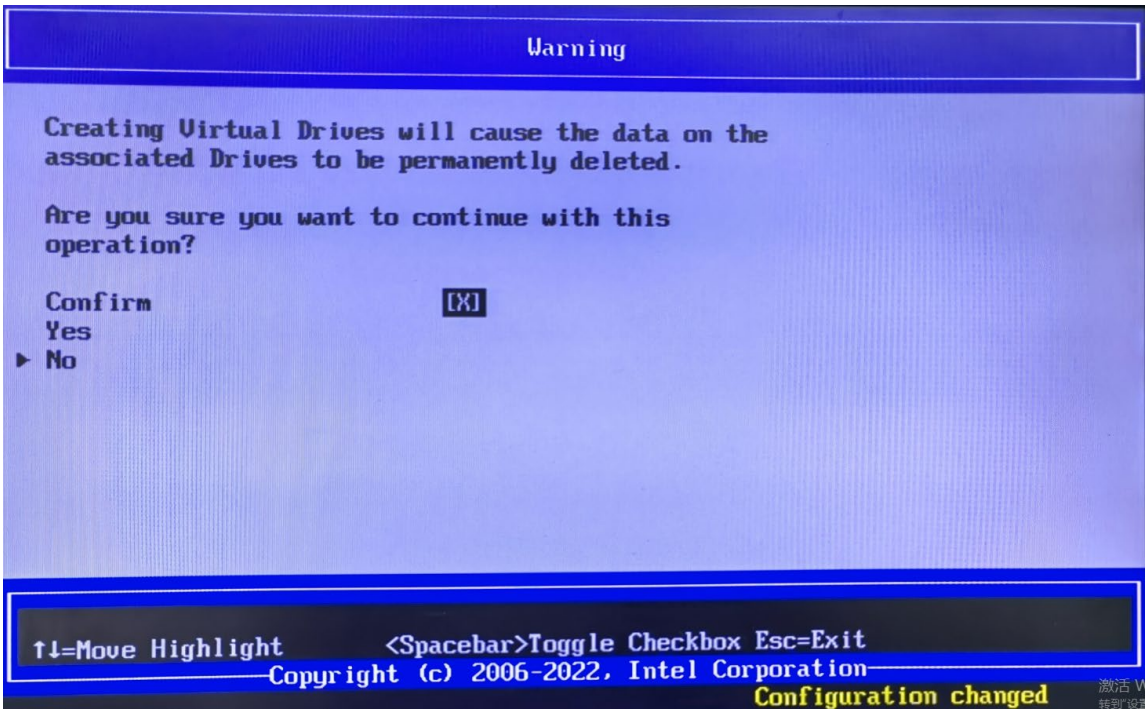
After you select the two drives and then apply the changes.



Selecting Disks for Span 1: When we press enter with the **Select Drives** highlighted for span 1, we can choose from the Unconfigured drives shown. For this example, we select the two drives left and we will then apply the changes. Once both spans have drives selected, we will see a screen like that shown below.

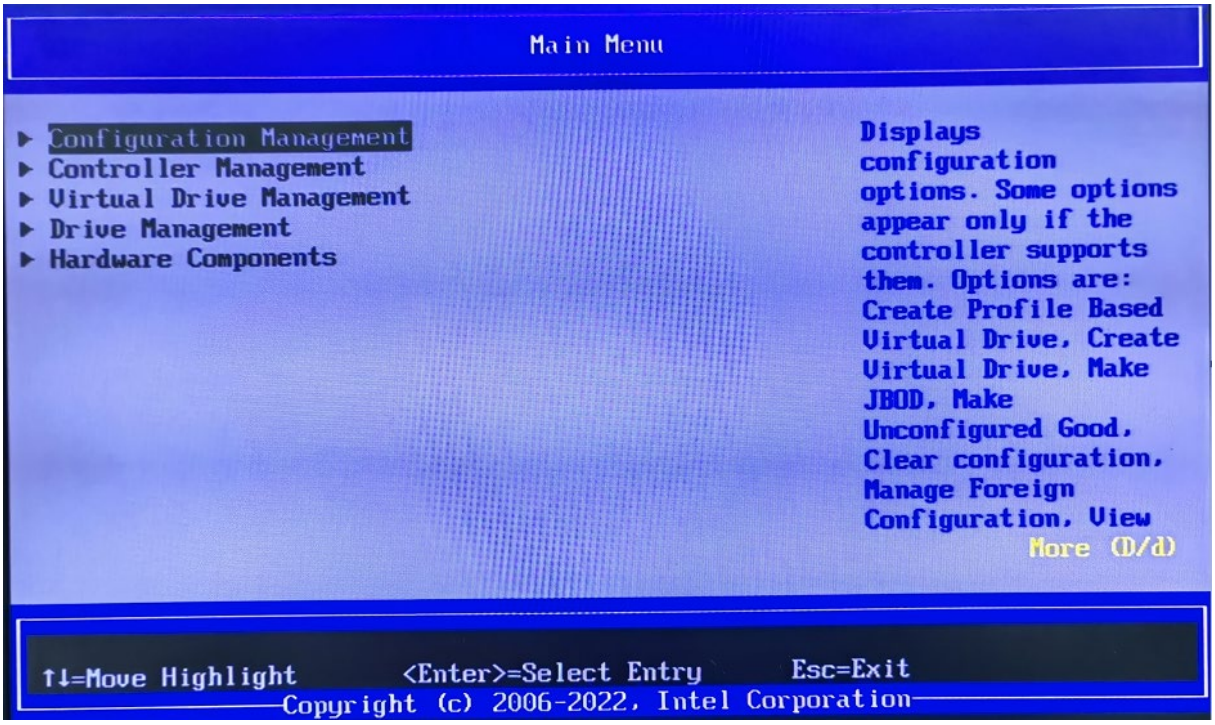


Saving Configuration and Confirmation: From here, navigate to Save Configuration and press the Enter key. At this point, you will be presented with a final warning that creating the drive will cause all data to be lost. Press the Enter key and enable the Confirmation button. Alternatively, you can use the + key to enable the confirmation button. Use the arrow keys to navigate down to Yes, and press Enter again. Your RAID array will now be created and begin initialization.



5.2 Deleting a RAID Volume

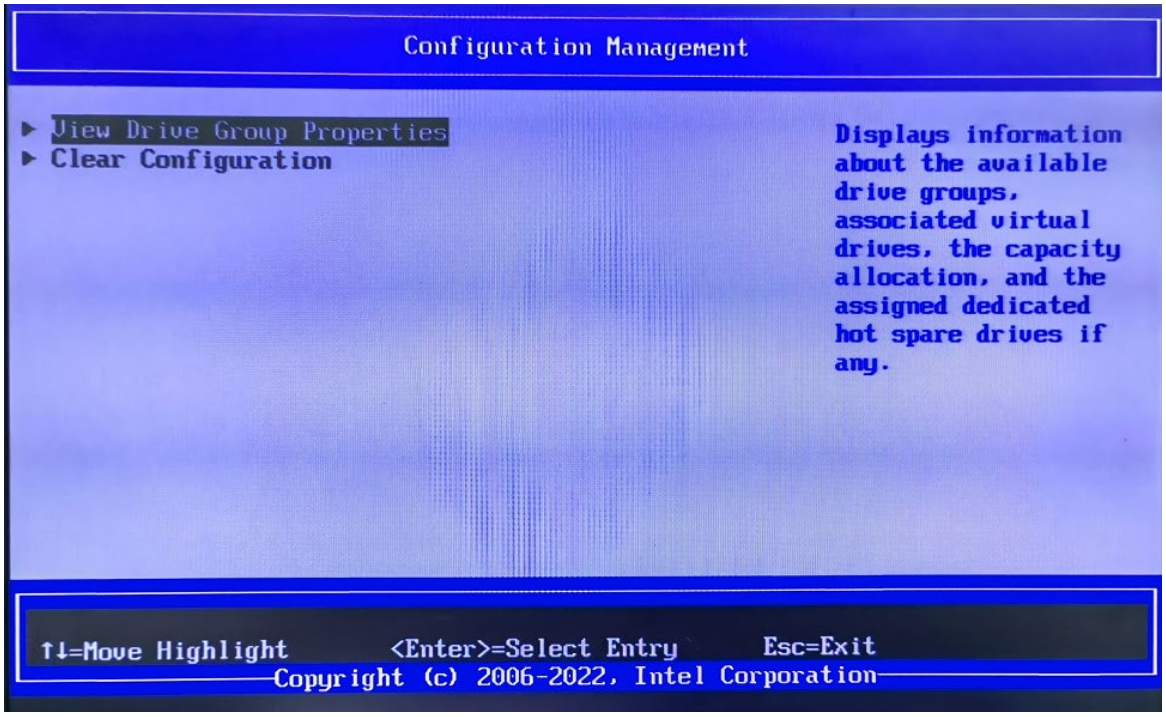
Enter the Device Configuration Menu: During system POST, press the F12 menu when the Dell logo isloading. You will see a progress bar appear if your keystroke was successful. You will now be presentedwith a menu like the below.



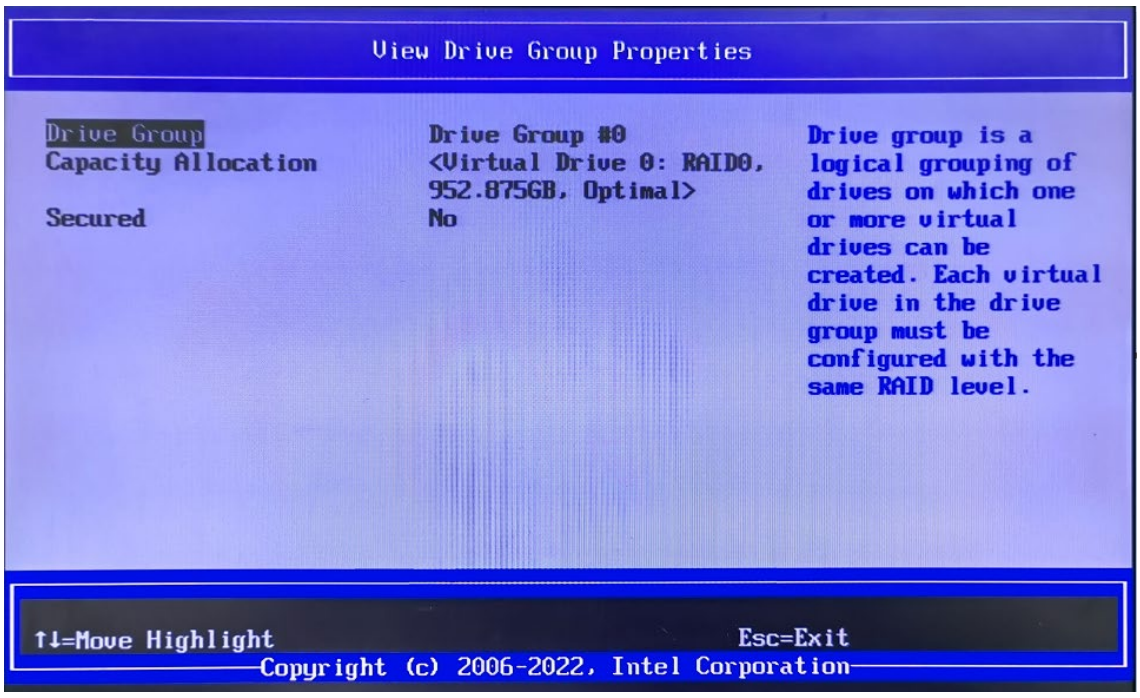
Using the ↑ and ↓ arrow keys, navigate to Device Configuration, and press the ENTER key on your keyboard. Depending upon the devices you have installed in the system, you may be presented with different options than the below. You can use the left and right arrow keys to navigate to the different devices you have installed in the system.

Select the UEFI-HII configuration utility for Broadcom RAID controllers: Once inside the MegaRAID Configuration Utility the user can navigate around using the up (↑) and down (↓) arrows on the keyboard. ESC can be used to exit the device and return to the Boot Options Menu. ENTER is used to select the currently highlighted menu option. These options are also described at the bottom right-hand corner of thescreen.

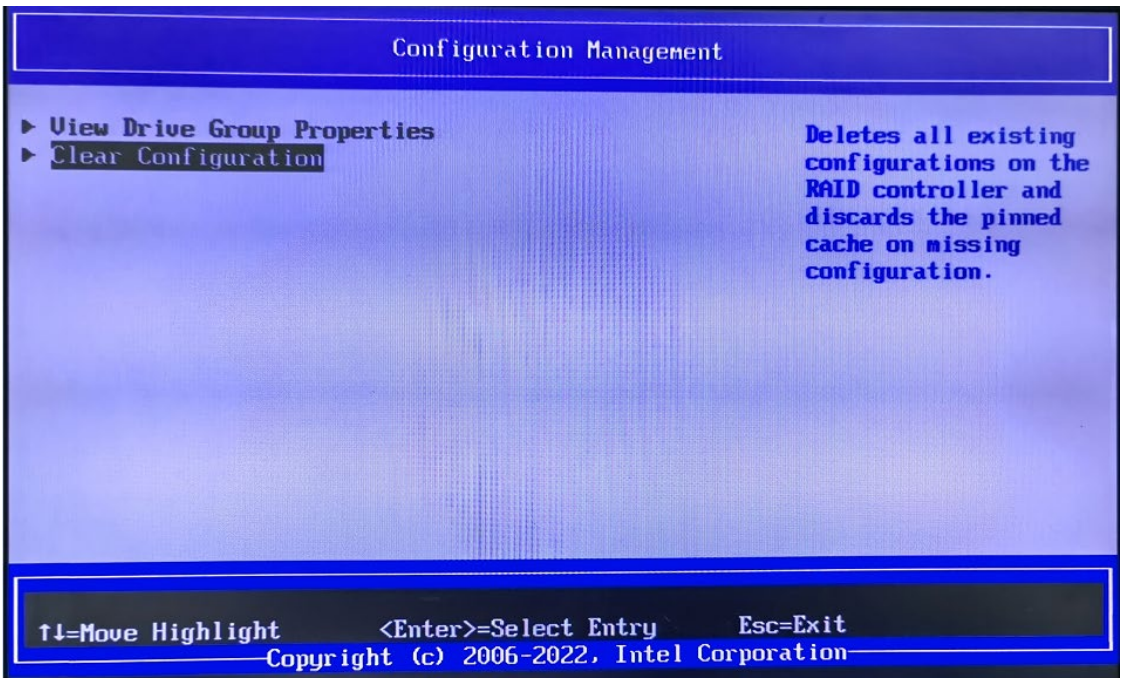
Managing a Virtual Drive: From this menu, use the down arrows to select Virtual Drive Management andpress the Enter key.



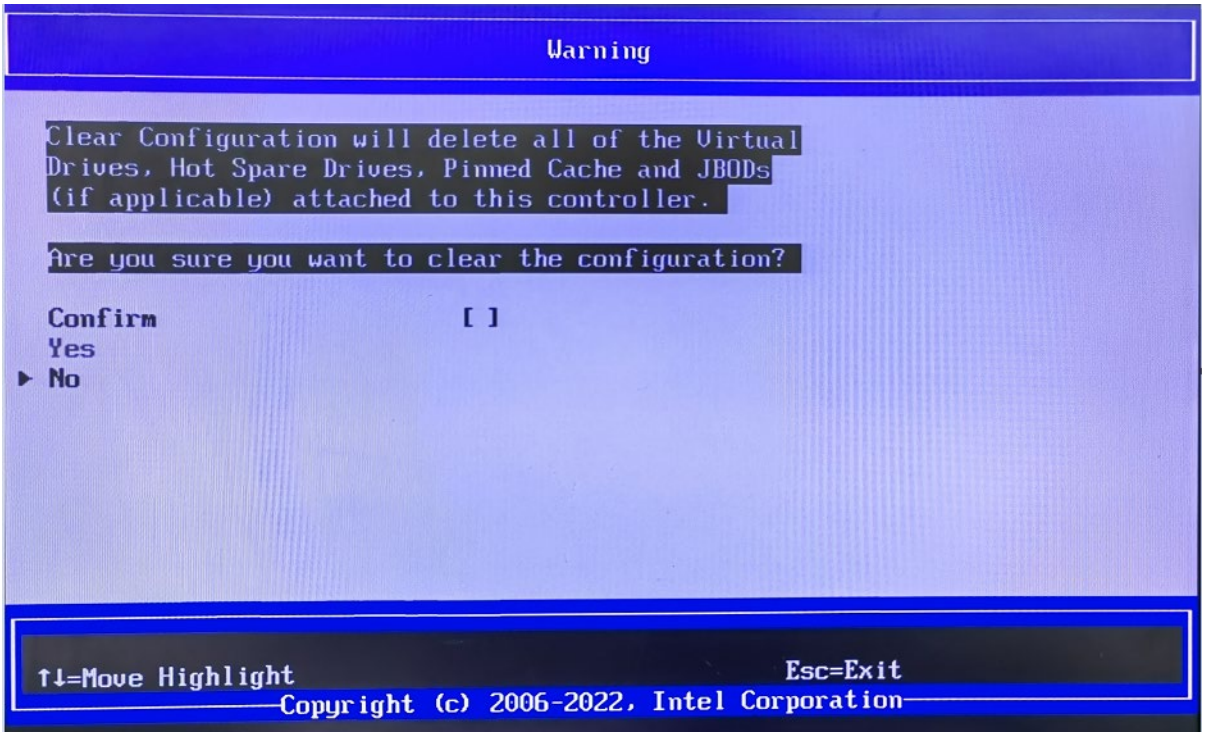
Selecting a Virtual Drive: Using the arrow keys, navigate to the Virtual Drive that you are planning to delete, and press the Enter key. The example below, only contains a single Virtual Drive.



Deleting the Virtual Drive: The next menu will show you the current status and configuration information forthe RAID drive. You are able to make changes to the RAID array at this point. To delete the Virtual Drive, use the arrow keys to highlight the Operation option and press the Enter key.

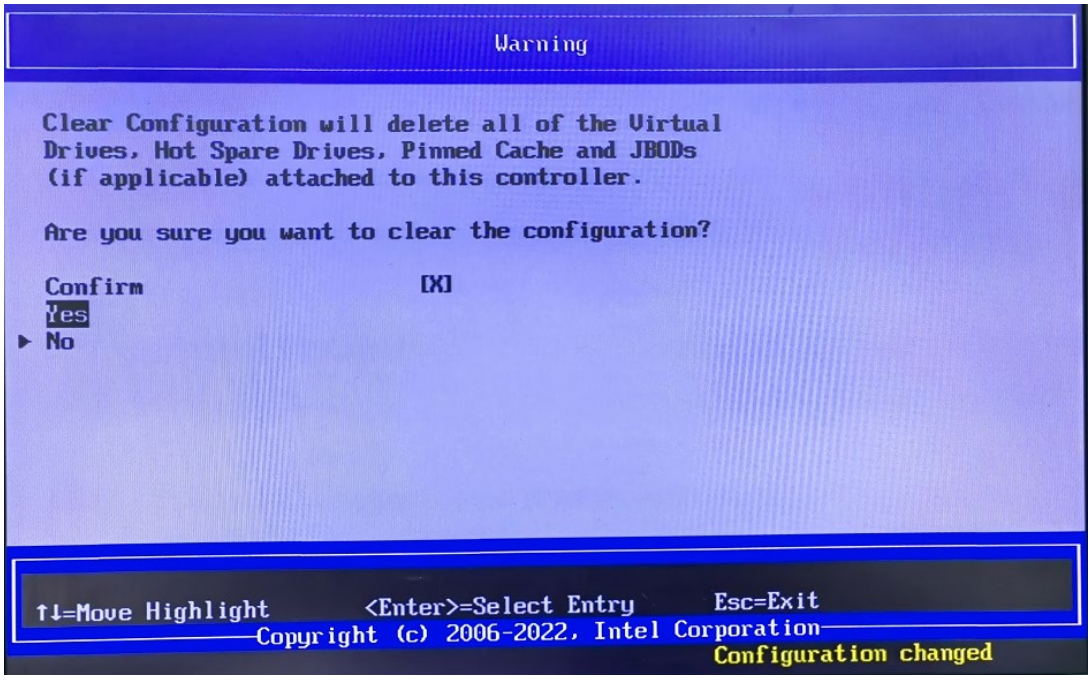


This will bring up a small submenu as shown below. Use the arrow keys again to navigate down and highlight the Delete Virtual Drive option as shown below and press Enter.

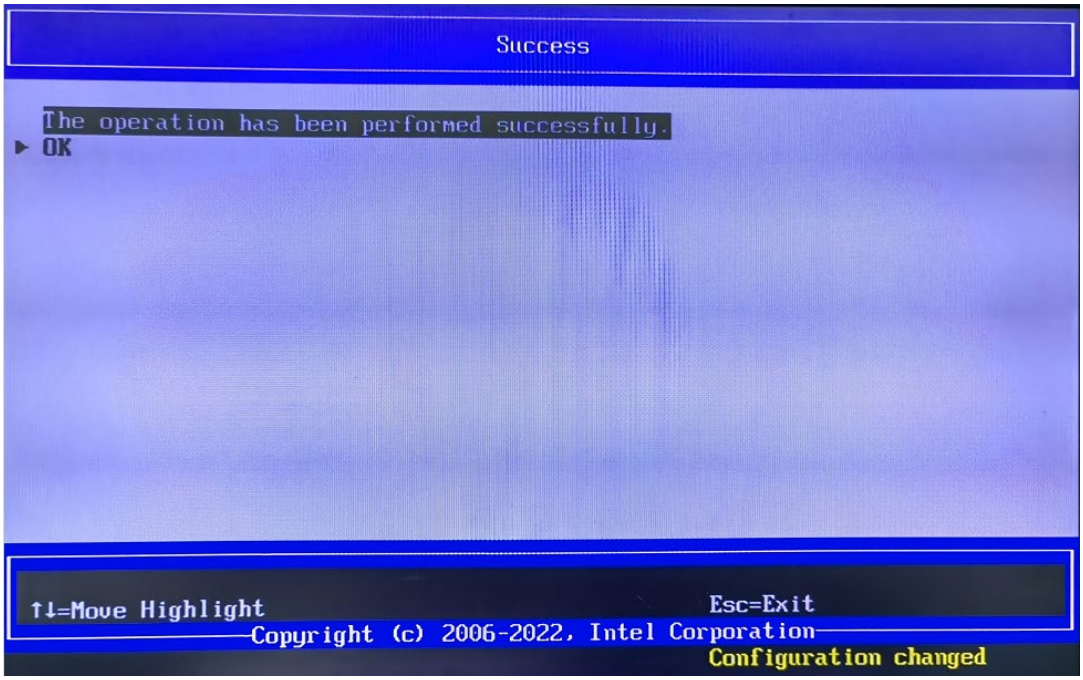


Perform Delete: A new option is presented to the previous menu as shown below, navigate to this option, and press Enter.

Confirmation: You will need to enable the confirmation and then confirm to actually delete the Virtual Drive.



Completion: After you enable and confirm, your RAID array is deleted.



6 Conclusion

There are multiple ways to manage a RAID configuration in Precision workstations. Only the basic methods under pre-boot environment are discussed here. There are advanced methods and applications available todo these basic steps and advanced configurations options. These methods include StorCLI, LSI Storage Authority (LSA). If you are an advanced user, please contact Dell support or the MegaRAID controller documentations to know more about these advanced options.